OpenCV provider

DENSO robot vision

(DENSO Robot Imaging Library)

Version 1.5.4

User's guide

February 25, 2015

ATTENTION:
DENSO WAVE doesn't assume the responsibility of any problems caused by the mistranslation of this document.

【Revision History】

Version	Date	Content
1.0.0.0	2007-01-30	First edition.
1.0.1.0	2007-04-06	Added several OpenCV commands; OcvTester bugs fixed.
1.1.0.0	2007-08-06	Added several new commands for pattern matching; the start image ID was changed from 0 to 1.
1.2.0.0	2007-11-21	Added triangulation functions and several OpenCV commands.
1.2.1.0	2007-12-05	Improve the camera setting functions; Added blob commands.
1.2.2.0	2008-02-06	Added put/get commands of a video control mode, 'Database' option, and Error table.
1.3.0.0	2008-02-29	Added Inner and Outer product commands.
1.3.1.0	2008-05-07	Added Blob commands. Improve MatchTemplate functions.
1.3.2.0	2008-09-17	Added Trim commands. Improve MatchTemplate2, MatchShapes2 and Undistort2 functions.
1.3.3.0	2009-01-20	Added Blob commands, calibration wizard to OcvTester, message transfer function and default camera function.
1.3.4.0	2009-06-03	Added several commands of the CaoController::Execute method.
1.3.5.0	2009-10-07	Added various commands, unify the rotation direction for all commands, eliminate CamShit command, error code, and sample program.
1.4.0.0	2010-7-01	Mounting of CaoController::get_VariableNames.
1.4.1.0	2010-11-02	Append a camera ID parameter to camera calibration commands.
1.4.1.1	2011-06-13	Added the capture screen.

1.4.2.0	2012-01-11	Added various commands. Correct SetRobCalDat.
1.4.2	2012-07-17	Document versioning rule was changed.
1.4.3	2012-09-06	Added the recovery function of the database file (mdb).
	2012-09-20	Added direction for "SetCameraCtrl".
1.4.4	2012-10-23	Added commands. "GetCameraFormatList", "GetCameraFormat", "SetCameraFormat"
	2012-12-05	[Bug Fix] Memory leak in message transfer function.
1.4.5	2013-03-13	Added various commands. SetCameraFrameRate, GetCameraFrameRate, IsUpdated, ClearUpdated
	2013-04-01	Added Original Error Code. Mounting of CaoFile::get_Attribute.
	2013-06-26	Add CaoWorkspace::AddController method option FrameRate
1.5.0	2013-07-22	Added FrameRate option and extended camera function Change name: OriN Vision > DENSO Robot Imaging Library Correct BlobMatchShapes.
	2013-09-24	Added CARD commands.
1.5.1	2013-11-18	Added extended camera commands.
1.5.2	2014-05-27	Added CARD commands. Added extended camera commands. Canon WebView Livescope camera correspondence.
1.5.3	2014-10-01	Added CARD commands.
1.5.4	2015-02-25	[Bug Fix] ADO Change error code.

【Hardware】

Model	Version	Notes

【Attention】

Additional license for " DENSO Robot Imaging Library " is required to use this provider.

Contents

1. Introduction 8
1.1. Installing license 9
2. Outline of provider 10
2.1. Outline 10
2.1.1. Image memory 13
2.1.2. Calibration 13
2.1.3. Triangulation 19
2.1.4. Message transfer function 21
2.2. Method and Property 22
2.2.1. CaoWorkspace::AddController method 22
2.2.2. CaoController::AddCommand method 23
2.2.3. CaoController::AddFile method 23
2.2.4. CaoController::AddVariable method 23
2.2.5. CaoController::Execute 23
2.2.6. CaoController::get_VariableNames property 24
2.2.7. CaoCommand::Execute method 24
2.2.8. CaoCommand::put_Parameter property 24
2.2.9. CaoCommand::get_Parameter property 24
2.2.10. CaoCommand::get_Result property 24
2.2.11. CaoFile::Execute method 24
2.2.12. CaoFile::get_Attribute property 24
2.2.13. CaoFile::put_ID property 25
2.2.14. CaoFile::get_ID property 25
2.2.15. CaoFile::get_DateLastModified property 25
2.2.16. CaoFile::Get_Size property 25
2.2.17. CaoFile::put_Value property 25
2.2.18. CaoFile::get_Value property 25
2.2.19. CaoFile::get_Help property 25
2.2.20. CaoController::OnMessage event 25
2.3. Variable list 26
2.3.1. Controller class 26
2.3.2. File class 26
2.4. Error code 27
3. Sample program 28
3.1. CaoScript sample program 28
3.2. Other sample programs 28

4. Command Reference 30
4.1. Controller class 35
4.1.1. Video setting 35
4.2. File class 46
4.2.1. General 46
4.2.2. Edit 53
4.2.3. Filter 58
4.2.4. Mask 73
4.2.5. Draw 79
4.2.6. Contours 86
4.2.7. Blob 92
4.2.8. Histogram 99
4.2.9. Matching 102
4.2.10. CARD 109
4.2.11. CAL 112
4.2.12. Misc. 128
4.3. Command class 138
4.3.1. Triangulation 138
5. OcvTester 144
5.1. Outline 144
5.2. Main screen 145
5.2.1. Object window 145
5.2.2. Log window 145
5.2.3. Menu 146
5.3. Image window 148
5.4. DENSO Robot connection window 151
5.5. Camera Settings window 153
5.6. Triangulation window 153
5.7. Calibration Wizard 155
5.7.1. Overview 155
5.7.2. Step 0: Select calibration target 156
5.7.3. Step 1 : Set camera calibration parameter 157
5.7.4. Step 2 : Acquire chessboard image 158
5.7.5. Step 3 : Map world coordinate and robot coordinate 159
5.7.6. Step 4 : Comlete Wizard 160
5.8. Lookup table editor 160
5.9. Image sampling window 161

5.10. Haar training window.....163
Appendix A. OpenCV method implementation list.....166
Appendix B. uVision21 equivalent OpenCV method 181
Appendix C. Intel License Agreement For Open Source Computer Vision Library 185

1. Introduction

The OpenCV provider is a provider that uses OpenCV image processing library. The image-processing library is developed by Intel Corporation.

DENSO Robot Imaging Library(RIL) is a tool set combining ORiN (Open Robot interface for the Network) and OpenCV (Open Source Computer Vision Library)[1] as a platform of Hand-eye system. The platform is not only just combining those two technologies but also fusing it into one ORiN provider. Therefore users can make a robot vision application program based on ORiN programming model easily. In addition, common functions such as model management are implemented in the provider module. This means that RIL provides the good balance of high speed processing and usability.

The goal of RIL is to provide the environment which an application engineer can make a hand-eye system easily with low-cost. To achieve this goal, RIL consists of only software, and it can use many cameras on the market. The architecture of RIL is shown below.

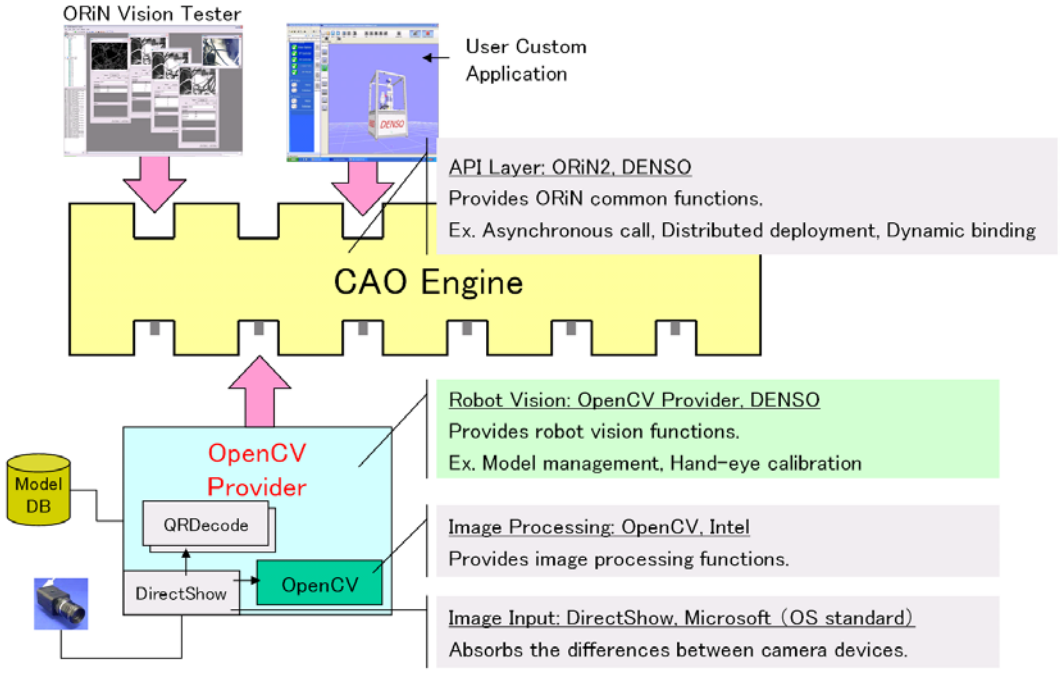


Figure 1-1 Architecture of RIL

[1] OpenCV is a vision library developed by Intel, and it's opened under the License Agreement (Appendix D).

1.1. Installing license

To use OpenCV Provider, you need to install ORiN2 SDK, and also need to input "DENSO Robot Imaging Libary" license information. If you would like to install it for evaluation, please use the following license.

CVG3-MZPB-7W2G-L43Q (valid for 3 months)

How to add the license is as follows.

1. Run the CaoConfig tool from the [Start] menu, and select the [Cao Provider] tab.
2. Select the [OpenCV CAO Provider] item on the provider list.
3. Click the [...] button of the license input box.
4. Click the [Add] button in the "ORiN2 License Manager" window.
5. Input a license key, and click the [OK] button.
6. Click the [Close] button to exit.

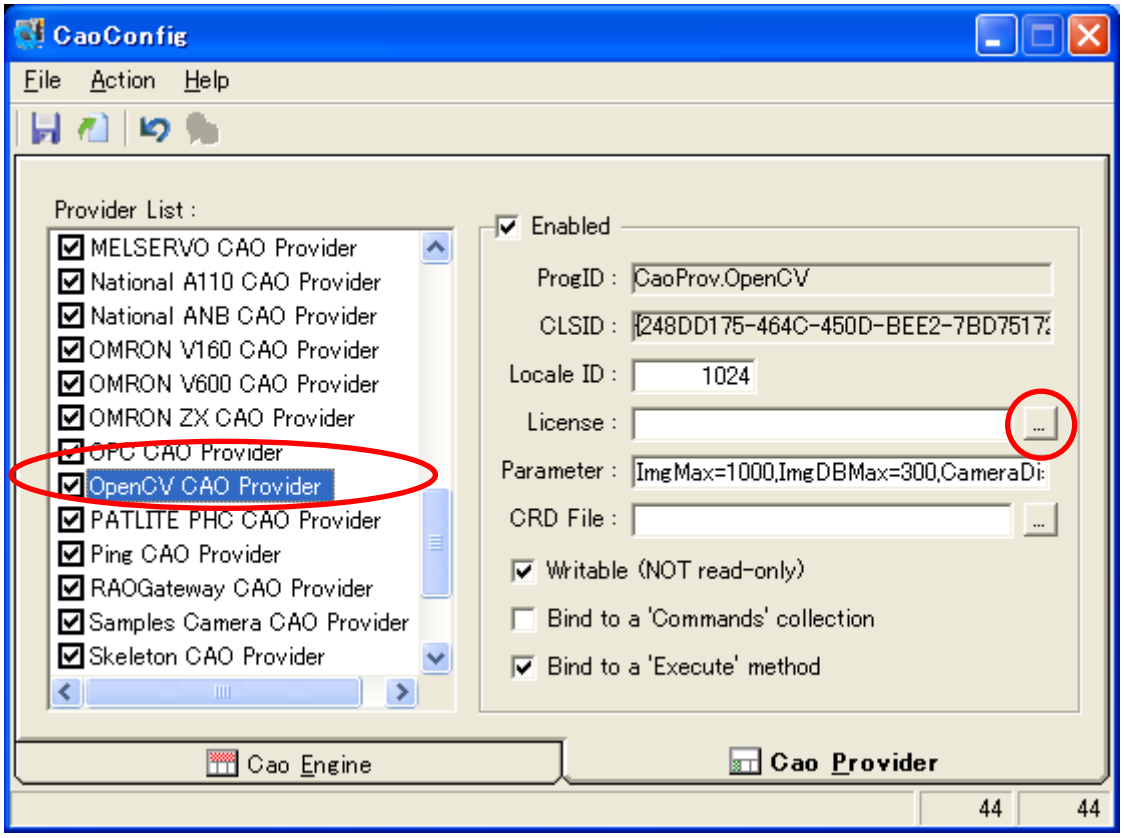


Figure 1-2 Installing 'DENSO Robot Imaging Library' license

2. Outline of provider

2.1. Outline

The OpenCV provider acquires the image from the imaging device using DirectShow. OpenCV processes the acquired image according to the user application command. Therefore many kinds of imaging device supporting DirectShow on the market can be used with this provider. The processed image is stored in the image memory. Details of the image memory are described later.

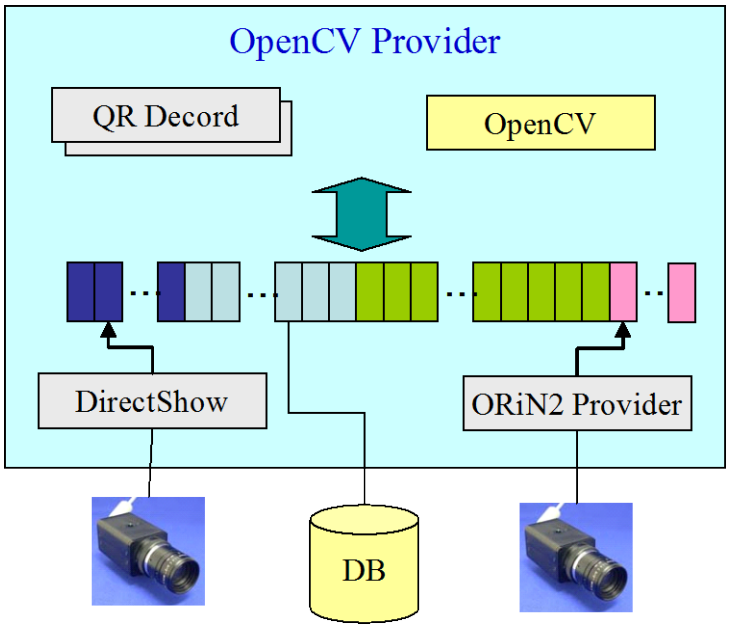


Figure 2-1 System Configuration

Certain types of cameras can be used as extended cameras. ORiN2 provider dedicated for each camera can configure the detailed setting of extended cameras.

ORiN2 provider used by extended camera may require the manufacturer's driver. For detailed information, refer to manuals of each provider. When you install the driver, do not install the driver of DirectShow.. [2]

The following two types of cameras can be recognized as extended camera..

Table 2-1 List of compatible models for extended camera

Extended camera 1	Basler GigE camera ORiN2¥CAO¥ProviderLib¥Basler¥Pylon¥GigE
Extended camera 2	IDS uEye camera ORiN2¥CAO¥ProviderLib¥IDS¥uEye

[2] If DirectShow driver is installed, the camera will not be recognized as an extended camera

Extended camera 3	Canon webView Livescope camera ORiN2¥CAO¥ProviderLib¥Canon¥WebView

The file format of OpenCV provider is DLL (Dynamic Link Library); that is automatically loaded from CAO engine when it is used. To use OpenCV provider, install ORiN2SDK or manually register the registry in reference with the following table.

Table 2-1 OpenCV provider

File name	CaoProvOpenCV.dll
ProgID	CaoProv.OpenCV
Registry registration[3]	Regsvr32 CaoProvOpenCV.dll
Registry unregistration	Regsvr32 /u CaoProvOpenCV.dll

OpenCV provider uses registry to store configurations of image memory area and cameras. The configuration is changed with CaoConfig software. The following table shows configuration items.

[3] Manual registration/unregistration is not necessary if the provider is installed by ORiN SDK.

Table 2-2 CaoConfig Parameter strings

Parameter	Meaning
Database=<Database file name>	Specify an absolute file path of ACCESS database. If omitted, the system uses the default database. That is 'opencv_en.mdb' stored in the bin directory. Please use the following file as a template. <OpenCV>¥Bin¥opencv_master_en.mdb
DefaultCamera=<default camera ID>	Specify default camera ID (default: 1). If ID option is omitted for AddFile, Default Camera ID is used for file object creation.
ImgMax=< image memory size >	Specify the entire image memory size. (default: 200)
ImgDBMax=< database area size >	Specify the image memory database area size. (default: 100) If the specified value is larger than ImgMax, all image memory is assumed to be stored in database.
CameraDisable [=<disabled camera>]	Specify the disabled cameras. Bit0 corresponds to camera ID=0, and Bit0 to Bit9 is specified. (default: 0x00) big ON: camera disabled bit OFF: camera enabled
FormatType =<camera0 display size>: [<camera1 display size>: ・・・ [<camera9 display size>:]]	Specify the display size of each camera. (default: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0) -1:default The value range depends on the camera. (0～) If an invalid value was specified, the default value is used instead.
FrameRate =<camera0 frame rate>: [<camera1 frame rate>: ・・・ [<camera9 display size>:]]	Specify the frame rate of each camera. (default: 0: 0: 0: 0: 0: 0: 0: 0: 0: 0) If an invalid value was specified, the default value is used instead.
ExtCamera [=<Basler GigE camera count >: [<IDS uEye camera count>]]	Specify the number of extended camera. (default: 0:0)

2.1.1. Image memory

OpenCV provider can store the image data in the two types of data area, database area and memory area. The data stored in the database area remains even if OpenCV provider unloaded (non-volatile), but the access speed is very slow. Therefore please don't use database area for a temporally use. On the other hand, the access speed of the memory area is fast, but the data stored in the area is cleared at the end (Volatile).

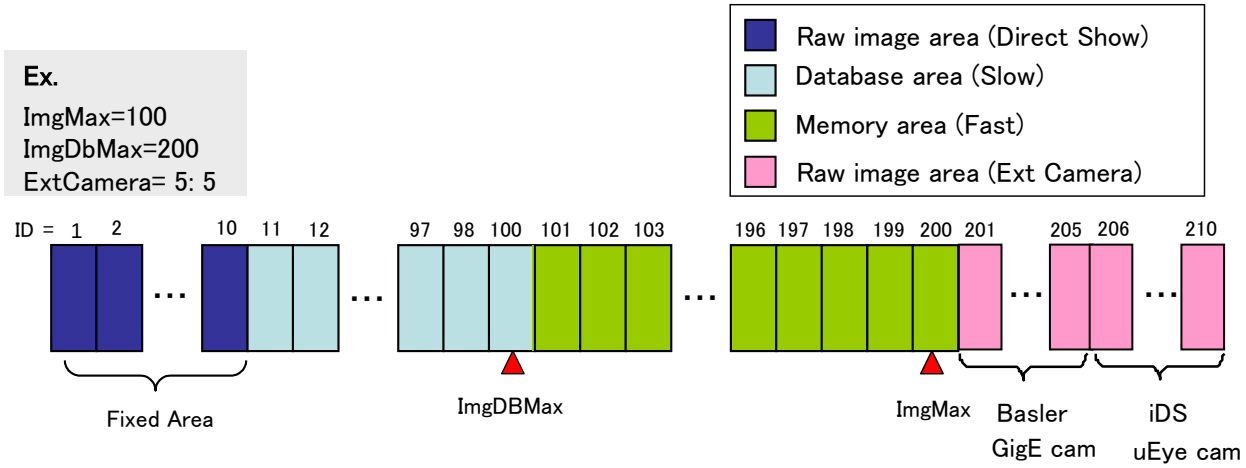


Figure 2-2 Image storage area

2.1.2. Calibration

The calibration commands of OpenCV provider can be divided into two categories, camera calibration and robot-camera calibration. Those commands are as follows:

- Camera calibration:

  CalibrateCamera, GetCamCalData, SetCamCalData, GetCamCalExtData, SetCamCalExtData, GetPosFromCam, GetCamPos, Undistort2

- Robot-calibration:

  CalibrateRobot, GetRobCalData, SetRobCalData, GetPosFromRob, GetRobPos

The relation among three coordinates, the world coordinate, camera coordinates and robot coordinates, are shown below: where

- The origin of the world coordinate is "Origin".
- The origin of a robot coordinate is "Base".

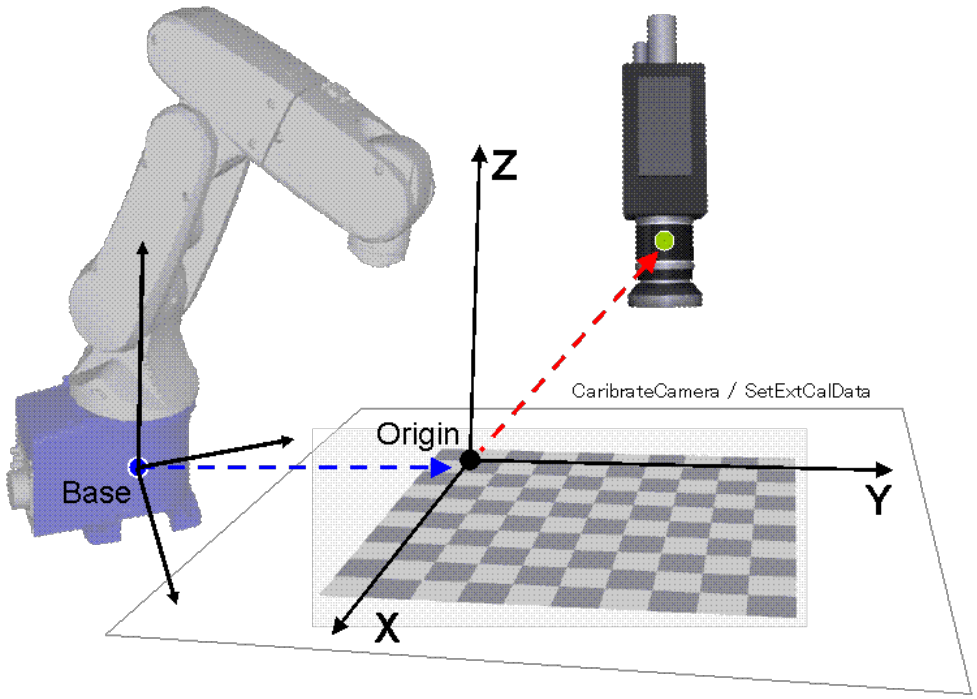


Figure 2-3 Robot -Camera Calibration

The triangulation commands of CaoCommand class need to be done the camera calibration. The procedure is as follows.

2.1.2.1. Camera calibration

OpenCV Provider provides a simple calibration method using a chessboard to calibrate the intrinsic parameters and the extrinsic parameters of the camera. The procedure is as follows.

[Step 1] Prepare chessboard image

Each camera requires at least five chessboard images. Store these images into appropriate consecutive image area, e.g. 101-105. The first image is used as a reference image to calculate external parameter. Input the reference image ID into 'Input ID' parameter of 'CalibrateCamera' command. The plane on which the chessboard is placed when picturing the reference image is called as reference plane(Figure 2-4). The following directory of ORiN2 SDK stores the chessboard image that can be used for calibration.

<ORiN2>/CAO/ProviderLib/OpenCV/Doc/Chessboard.pdf

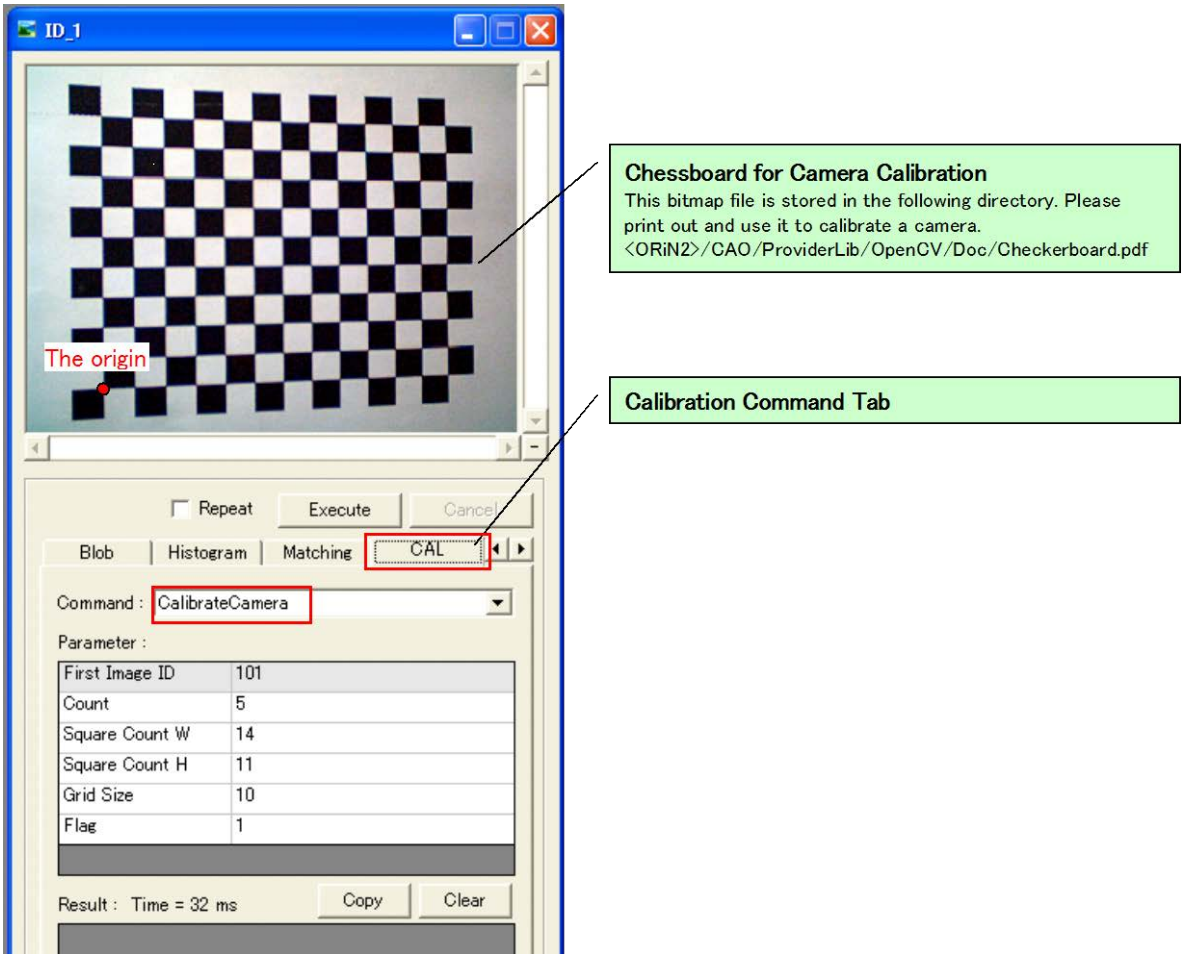


Figure 2-4 Calibration Dialogue

There are two ways to take 5 images, a camera shift and a chessboard shift (Figure 2-5). In both cases, the right-top corner of the left-bottom "**black box**" becomes the origin.[4]

[4] In case of a chessboard which there is no black box in the left-bottom corner, the origin may become the right-top corner. Please confirm the origin by GetCamPos after executing CalibrateCamera.

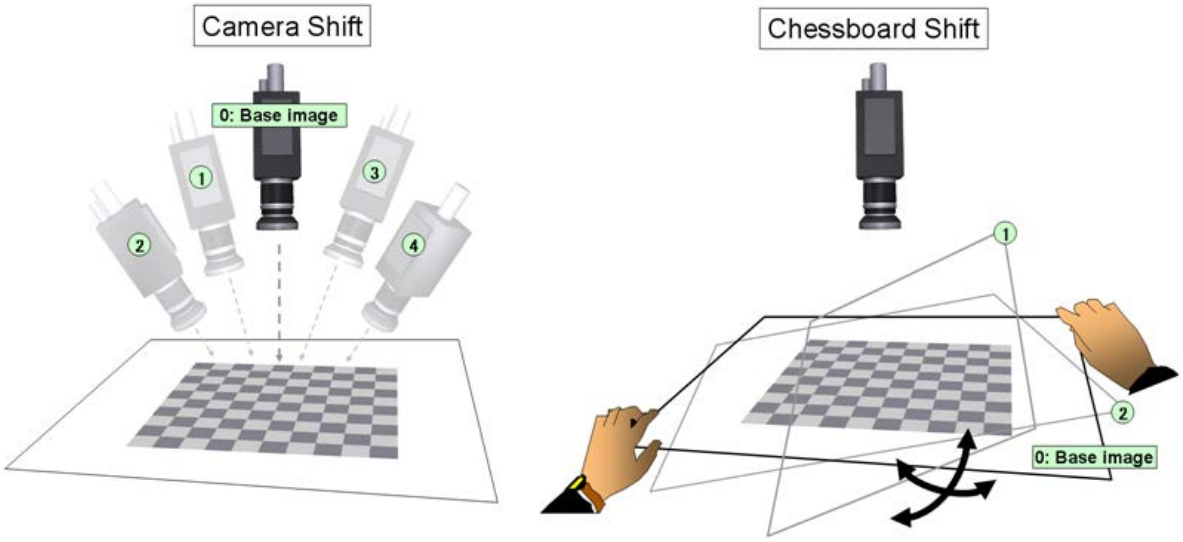


Figure 2-5 Two ways to take chessboard images

[Step 2] Calculate camera parameters

Use 'CalibrateCamera' command to calculate camera parameters. When you use chessboard file image in SDK, please specify the values for 'Square count W', 'Square count H' and 'Grid size (mm)' as written on each image.

After setting these values, press [Execute] button (if you use OpenCV tester), or invoke 'CalibrateCamera' command (if you directly call the command) for camera parameter calculation. The calculated data is automatically stored in database. Use 'GetCamCalDat' command to get the stored parameter value.

[Step 3] Confirm the result

You can get the correct value (X, Y, Z) in the world coordinate after calibration. Please perform 'GetPosFromCam' command with a reasonable value (Xc, Yc) in the camera coordinate, and then (Xw, Yw, Zw) corresponding (Xc, Yc) returns. In case of two points on the world coordinate, the distance of two points can be calculated correctly.

In addition, by using 'Undistort2' command, a distorted image can be undistorted. Please check whether the linearity of the image was improved.

[Caution]

GetPosFromCam function assumes that the target point is on a plane where Z=0 in the world coordinate system. Therefore, positioning error may occur if the camera detected target point is not on the Z=0 plane (e.g. X1obj – X1cal in Figure 2-6 shows the positioning error.)

If the target object is a three-dimensional object with height, calibration reference plance should be

aligned to the target object height. For measuring accurate 3D coordinate position, please use triangulation method command.

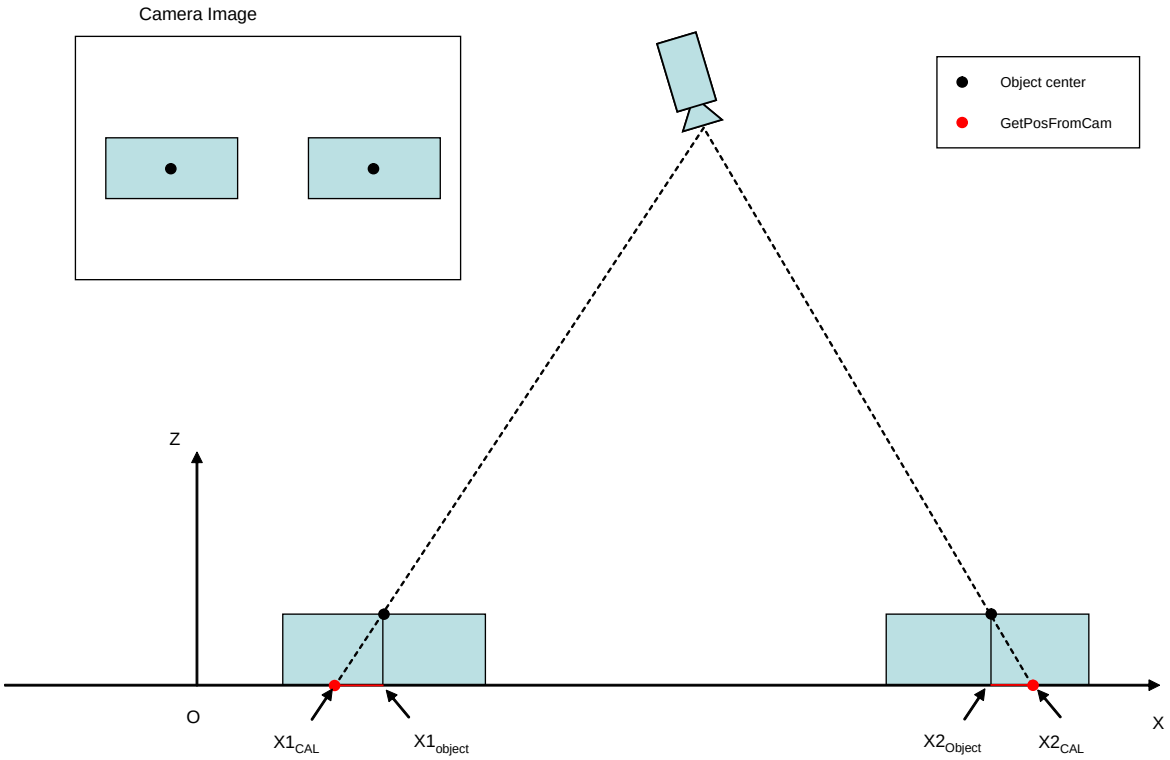


Figure 2-6 Camera image and actual position error in camera calibration

2.1.2.1.1. Distortion correction

The shot image of the camera has distortion, because camera lens also has distortion. Camera calibration calculates the parameters to correct this type of distortion.

'Undistort' command transforms distoted image to distortion-corrected image.

'GetPosFromCam' command transforms camera coordinate to world coordinate. By assigning distortion correction flag of this command as TRUE, distorted image coordinate is directly converted to world coordinate.

Transformation from distorted image to undistorted image is supported, but undistorted image to distorted image is not supported.

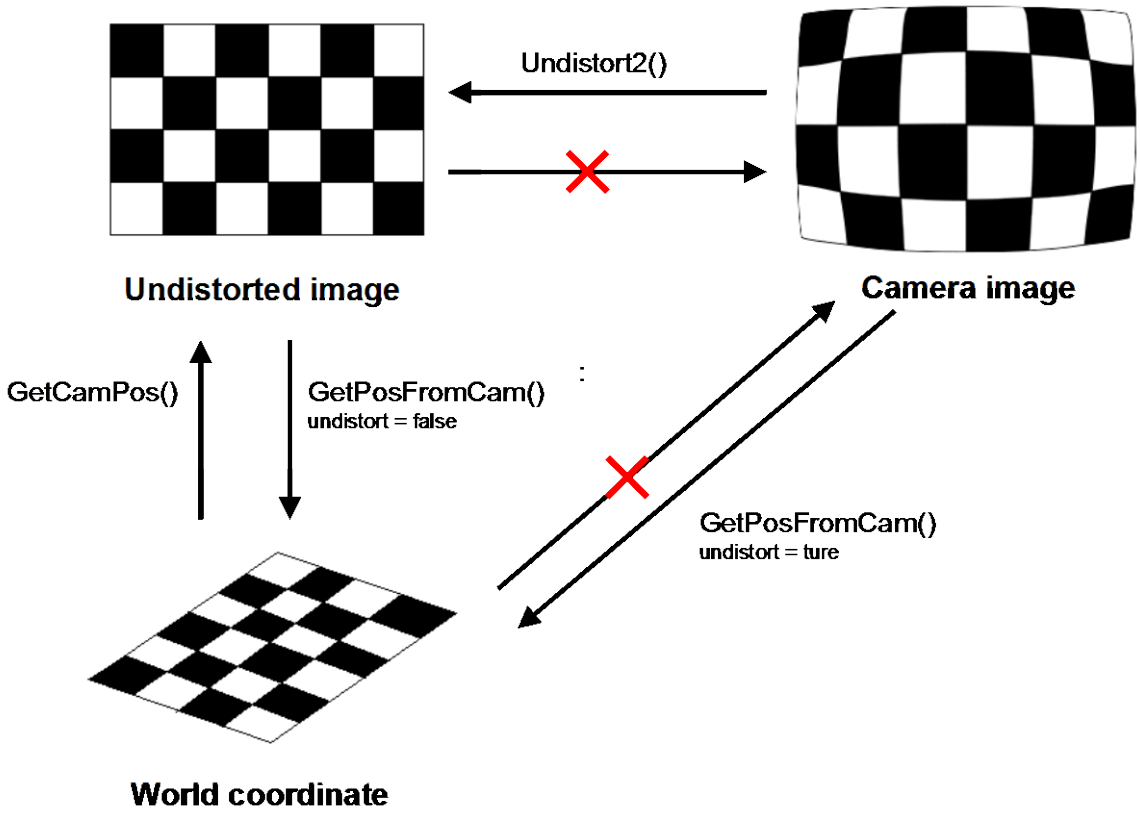


Figure 2-7 Distortion correction commands

2.1.2.2. Robot calibration

There are two ways to connect the world coordinate and a robot coordinate:

1. Calculate the robot parameters between the world coordinate and a robot coordinate by using OpenCV provider functions.
2. Set the world coordinate as a work coordinate of the robot.

In this section, the 1st procedure is shown. Regarding the 2nd procedure, please refer to the robot manual. If you don't have to connect the world coordinate and a robot coordinate, the following procedure is not required.

[Step 1] Calculate the robot parameters

Calculate the robot parameters by using 'CalibrateRobot' command. This command requires the following 3 points:

- The origin of the world coordinate.
- One point on the X axis of the world coordinate.
- One point on the X-Y plane of the world coordinate.

Please note that those three points should be the points of a robot coordinate.

After performing the command, the robot parameters are stored in the database. To get the parameters from the database, use 'GetRobCalDat' command.

[Step 2] Confirm the result

You can get the correct value (X, Y, Z) in the world coordinate after calibration. Please perform 'GetPosFromRob' command with a reasonable value (Xr, Yr, Zr) in the robot coordinate, and then (Xw, Yw, Zw) corresponding (Xr, Yr, Zr) returns.

2.1.3. Triangulation

OpenCV provider has triangulation function using two cameras. To use the function, the above described camera calibration and robot-camera calibration need to be completed. There are three commands for triangulation.

Triangulation, TriHaarDetect, TriMatchShapes, TriMatchTemplate

For 'Triangulation' command, two camera image coordinates, (X1c,Y1c) and (X2c,Y2c), are specified for triangulation calculation. (Figure 2-8). For other commands, HaarDetect, MatchShapes2 and MatchTemplate2 commands are used to detect corresponding points automatically, and then 'Triangulation' command uses the detected points. Please notice that the return values of (X, Y) of these three commands have different meanings. For HaarDetect, the adjustment is performed as following.

- HaarDetect: Add half of W and H to the first result of (X, Y), i.e. (X + W/2, Y + H/2)
- MatchShapes2: Use result as it is.
- MatchTemplate2: Use result as it is.

In the same way, you may develop your original triangulation command by combining your original corresponding point detection algorithm and 'Triangulation' command. In the actual application, corresponding point detection can be optimized for each application. If the position accuracy or detection speed is not enough, we recommend to develop original routine for position detection.

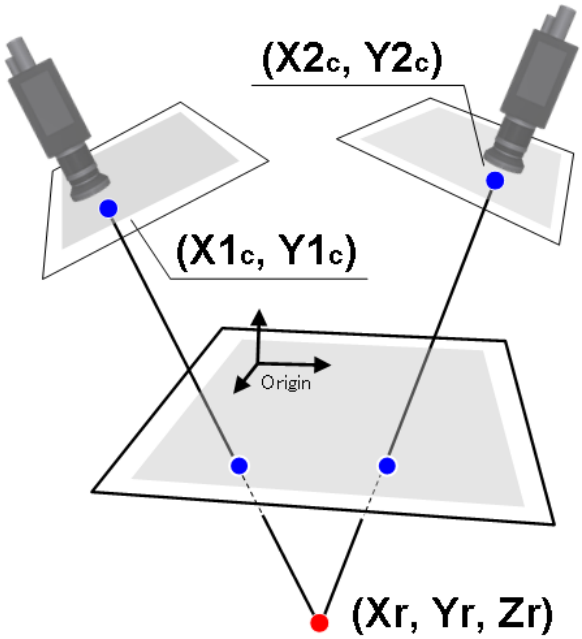


Figure 2-8 Triangulation

Triangulation command returns the coordinate position from the origin of the reference image. Camera position is also represented using the same origin, and you can easily calculate the distance between the camera and the target object using Distance command.(Figure 2-9).

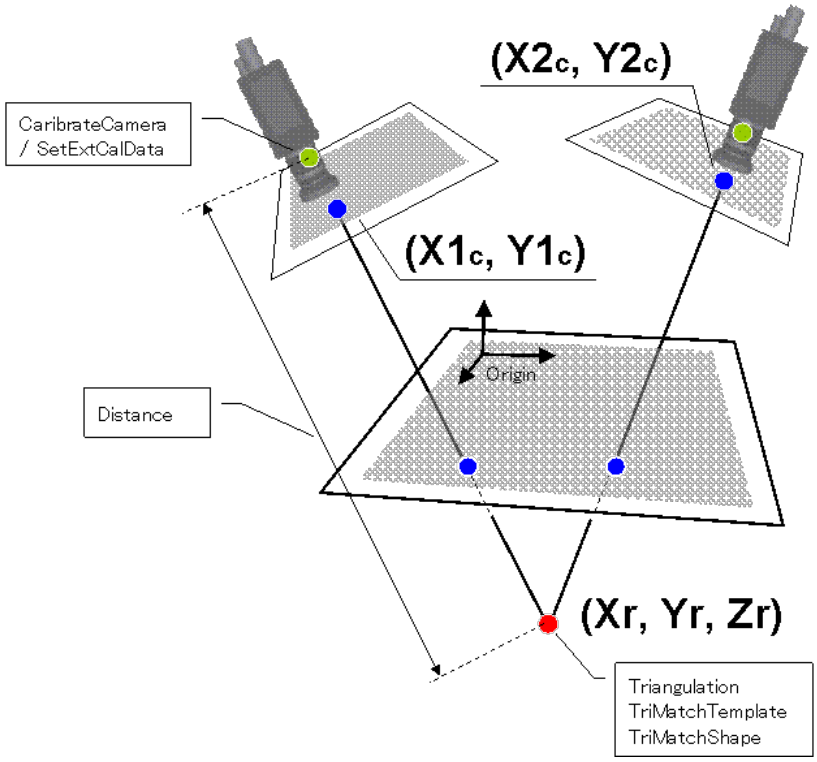


Figure 2-9 Distance calculation

2.1.4. Message transfer function

By using message transfer function of CAO engine, image data stored in received message can be transferred to the specified image ID.

Transfer destination is specified by MsgDestID option of AddController(). To transfer images from plural sources to different image ID destinations, create plural CaoController objects and specify different destination image ID in AddController().

When transfer message data is not bitmap file, the data is not stored.

2.2. Method and Property

2.2.1. CaoWorkspace::AddController method

The OpenCV provider searches camera and performs connection process at AddController.

If you don't use the option character, it uses setting which registered in registry. (refer 2.1)

Format. AddController(<bstrCtrlName: BSTR>,<bstrProvName: BSTR>,
<bstrPcName: BSTR > [,<bstrOption: BSTR>])

bstrCtrlName : [in] controller-name

bstrProvName : [in] provider name. "CaoProv.OpenCV fixed value ="

bstrPcName : [in] provider process execution machine name

bstrOption : [in] option character string

Table 2-3 option character string table

Option	Meaning
QREnabled=True/False	"QRDecode" Command Enable. Default=False
OCREnabled =True/False	" OCRead " Command Enable. Default=False
MsgDestID=<image ID>	Specify destination image ID for message transfer.
FormatType=t1:t2:t3:t4:t5:t:t7:t8:t9:t10	Specify the display size of each camera. If an invalid value was specified, the default value is used instead. Ex. Use No2 camera format to camera2. FormatType=0:2:0:0:0:0:0:0:0:0
FrameRate=f1:f2:f3:f4:f5:f6:f7:f8:f9:f10	Specify the frame rate of each camera. If an invalid value was specified, the default value is used instead. Ex. Use 30 frame rate to camera2. FormatType=0:30:0:0:0:0:0:0:0:0

When AddController failed, it might be caused by the following problems.

- Camera device failure

  A camera device might not be working properly. Please check the camera with "amcap.exe" program included in the DirectX samples.

- Image database failure

  A database file might be broken. Please delete "opencv.mdb" file located in the

"CAO/ProviderLib/OpenCV/Bin" directory. A new database file will be generated automatically at the next startup. But all image data stored in the deleted file are discarded.

2.2.2. CaoController::AddCommand method

Create CaoCommand for triangulation.

Format AddCommand(<bstrName: BSTR > [,<bstrOption: BSTR>])

bstrName : [in] command name

bstrOption : [in] option character string(unused)

Refer4.3.1for available commands.

2.2.3. CaoController::AddFile method

Create a file object to access camera device and the image memory.

Format AddFile(<bstrName: BSTR > [,<bstrOption: BSTR>])

bstrName : [in] arbitrary name

bstrOption: : [in] option character string

Table 2-4 Option character string of CaoWorkspace::AddFile

Option	Meaning
ID[=<image number>]	Initially connected image memory number (default: default camera ID) When this option is omitted, file object is connected to the default camera ID specified in "DefaultCamera of Table 2-2 .

2.2.4. CaoController::AddVariable method

Creates variable object of camera device and image memory information. Only variable names on 2.3.1can be used for this method.

Format AddVariable(<bstrName: BSTR > [,<bstrOption: BSTR>])

bstrName : [in] Arbitrary name

bstrOption : [in] Option character string

2.2.5. CaoController::Execute

Execute specified command.

Refer to 4.1 for details of each commands.

2.2.6. CaoController::get_VariableNames property

The variable list is acquired. Please refer to 2.3.1 for the acquired variable.

2.2.7. CaoCommand::Execute method

Execute specified command.

Refer to 4.3 for details of each commands.

2.2.8. CaoCommand::put_Parameter property

Set parameters for a command.

Refer to 4.3 for details of each commands. This property does not check illegal parameters.

2.2.9. CaoCommand::get_Parameter property

Get parameters set by 2.2.8 . When the parameter is not set, VT_EMPTY is Return valued.

2.2.10. CaoCommand::get_Result property

Get latest execution result of 2.2.7. Refer to 4.3.1 for result of each commands.

2.2.11. CaoFile::Execute method

Execute image processing or the arithmetic processing specified by the command name.

The arguments of the Execute method are specified by BSTR for command and VARIANT array for parameters.

Format [<vntRet: VARIANT> =] Execute(<bstrCmd: BSTR > [,<vntParam: VARIANT>])

bstrCmd	: [in] command
vntParam	: [in] parameter
vntRet	: [out] Return value

Refer to "4 Command Reference" for details of each command.

2.2.12. CaoFile::get_Attribute property

Get the kind of image memory.

2	Camera
3	Database area
4	Memory area

2.2.13. CaoFile::put_ID property

Change referred image memory.

2.2.14. CaoFile::get_ID property

Get ID of the currently referring image memory.

2.2.15. CaoFile::get_DateLastModified property

Get last modified date of the currently referring image memory.

VT_EMPTY will be returned if the memory does not have image.

2.2.16. CaoFile::Get_Size property

Get file size of the referring image memory.

2.2.17. CaoFile::put_Value property

Overwrite BMP format image to the currently referring image memory.

The image is overwritten as a color image.

2.2.18. CaoFile::get_Value property

Get BMP format image from the currently referring image memory.

Color image is acquired as 24bits bitmap image, and grayscale image is acquired as 8bits bitmap image.

2.2.19. CaoFile::get_Help property

Get character strings that have been set by the PutHelp command.

If camera area is specified, a camera name will be obtained.

2.2.20. CaoController::OnMessage event

Updating image data generates OnMessage event of CaoController class. With this event, Message::Number property is set to 1, and Message::Value property is set to the image number.

2.3. Variable list

2.3.1. Controller class

Table 2-5 Controller class system variable list

Variable identifier	Data type	Explanation	Attribute	
			get	put
@IMG_MAX	VT_I4	Size of the entire image memory	√	-
@IMGDB_MAX	VT_I4	Size of data base area of image memory	√	-
@CAM_COUNT	VT_I4	Number of connected cameras	√	-
@VERSION [V1.3.5 or later]	VT_BSTR	Provider version	√	-
@EVENT_ENABLED [V1.3.5 or later]	VT_BOOL	CAO message event generation setting	√	√
@EXT_CAM_COUNT [V1.4.6 or later]	VT_I4 | VT_ARRAY	Number of extended camera. <Number of Basler GigE camera> <Number of IDS uEye camera>	√	-

2.3.2. File class

Table 2-2 File class system variable list

Variable identifier	Data type	Explanation	Attribute	
			get	put
@VALUE [V1.3.5 or later]	VT_UI1 | VT_ARRAY	Image data in the image memory Referring and assigning the variable has same effect as executing CaoFile::get_Value() and CaoFile::put_Value().	√	√

2.4. Error code

Open CV provider defines folloing specific error codes. For common error code for ORiN2, please refer to the error code section of "ORiN2 Programming guide".

Table 2-3 Specific error code for OpenCV provider

Error name	Error code	Explanation
E_CAOP_NO_LICENSE	0x80100000	There is no license. Please purchase an additional license.
E_CAOP_DB_RESTORE	0x80100001	The database file (mdb) was crashed. Because it was recoverd automatically from the last mdb, restartd your program.
E_CAOP_INITTERM	0x80100002	The another process is initializing or terminating. Please wait a minute.
E_CAOP_NOIMAGE	0x80100003	No image.
E_CAOP_LOCK_IMAGE	0x80100004	The another program is using the image.
Original error code.	0x801010xx	The original error code depending on a command. Please refer to the chapter 4.
OpenCV API Error	0x8011xxxx	OpenCV API error number will be assigned at "xxxx" part of the error code. Please refer OpenCV reference for the details.

3. Sample program

RIL programs can be developed with various programming languages (C/C++, VB, etc.) The easiest way is to use RIL is to use CaoScript, a VB Script based scripting language. CaoScript is included in ORiN2 SDK. Section 3.1explains CaoScript sample program. For other samples, refer to section 3.2

3.1. CaoScript sample program

This sample program is to detect target position (target image is stored in ID101), and move DENSO robot to the detected position.

```
' Create CAO object
Set rc = Cao.AddController("rc", "CaoProv.DENSO.NetwoRC", "", "Conn=eth:192.168.0.1")
Set robo = rc.AddRobot("vp")
Set vis = Cao.AddController("cv", "CaoProv.OpenCV", "", "")
Set rawImg = vis.AddFile("cam1", "ID=1")
Set tmpImg = vis.AddFile("mem1", "ID=101")
' Search and trace target by using pattern matching
OldX = -1: OldY = -1
Do
   ' Calculate threshold level by discriminant analysis method
   iT = rawImg.AutoThreshDiscrim(rawImg.CalcHistEx(255))
   ' Binarization & B/W inversion(1)
   rawImg.ThresholdEx 101, iT, 255, 1
   ' Shape matching
   res = tmpImg.MatchShapes2(11, 2, 0.2)
   ' Calculate position shift length and move robot
   If (OldX <> -1) Then
      v = "V(" & (OldX - res(0)) & "," & (OldY- res(1)) & ",0)"
      robo.Draw 1, v, "next"
   End If
   OldX = res(0): OldY = res(1)
Loop
```

3.2. Other sample programs

Other RIL sample programs are located in the following directory.

<ORiN2>¥CAO¥ProviderLib¥ OpenCV ¥Samples

Table 3-1 Sample program list

Program	Contents	Language
3DTracking	Robot motion by pattern matching and triangulation.	Visual Basic 6
Benchmark	Short test programs for benchmark.	Excel VBA
CutImage	Cut camera 0 image from coordinate point (0,0) to 100 in width and 100 in height, and display the cut image. The cut image is preserved in memory #11.	Visual Basic 2005

DENSO NetwoRC	Search for a specified target image in the camera image, and store the detected coordinate into a variable of the controller with IP address "10.6.235.60".	Visual Basic 6
Filter	Display the image from camera in the following four patterns. ・raw image ・gray-scale image ・binary image Canny filtered image	Visual Basic 2005
FindCountoursEx	Execute FindCountoursEx command.	C
Histogram	Generate a histogram of camera 1 image.	Visual Basic 2005
Others	Robot motion by pattern matching.	CaoScript
SaveImage	Save camera 1 image in image memory #11.	Visual Basic 2005

4. Command Reference

This chapter shows the details of each OpenCV provider command. Regarding the detailed behavior of the commands depending on OpenCV library deeply, please refer the OpenCV manual like the followings. And regarding the used OpenCV functions in the OpenCV provider commands, please see 5.10.Appendix A.

[OpenCV Japanese manual] http://opencv.jp/opencv-1.0.0/document/

[OpenCV English manual] http://opencv.jp/opencv-1.0.0_org/docs/index.htm

Table 4-1 Controller class command list

Category	Command name	Function	
Video Setting			
	~~SetFormat~~[5]	~~Set a video format~~	
	~~GetFormatList~~[5]	~~Get a video format list~~	
	OpenFileterProperty	Open a filter property window	P.35
	OpenPinProperty	Open an output Pin property window	P.35
	SetCtrlMode	Set a video control mode	P.35
	GetCtrlMode	Get a video control mode	P.36
	GetRangeCameraCtrl	Get a parameter range of a camera control	P.36
	GetCameraCtrl	Get a parameter of a camera control	P.37
	SetCameraCtrl	Set a parameter of a camera control	P.37
	GetRangeVideoProcAmp	Get a parameter range of a video control	P.38
	GetVideoProcAmp	Get a parameter of a video control	P.39
	SetVideoProcAmp	Set a parameter of a video control	P.40
	GetCameraFormatList	Get camera format list.	P.41
	GetCameraFormat	Get camera format ID.	P.41
	SetCameraFormat	Set camera format ID.	P.41
	ExtExecSoftTrigger	Execute software trigger	P.42
	ExtRefreshImage	Refresh extended camera's image	P.42
	ExtInvoke	Execute extended camera's command	P.42
	ExtConnect	Connect extended camera.	P.43
	ExtDisconnect	Dicconnect extended camera.	P.43
	ExtIsConnected	Connection check of extended camera	P.44
	ExtGetConnectOption	Get extended camera's connection option	P.44
	ExtSetConnectOption	Set extended camera's connection option	P.44

[5] This command was integrated into the OpenPinProperty command.

Table 4-2 File class command list

Category	Command name	Function	
General			
	SetROI	Set a ROI (Region Of Interest)	P.46
	GetROI	Get current ROI.	P.46
	ResetROI	Reset current ROI setting.	P.47
	PutColor	Put color	P.47
	GetColor	Get color	P.48
	SearchPoint	Search point	P.48
	Trim	Trimming	P.49
	ImageSize	Get image size	P.50
	IsColor	Color image flag	P.50
	IsEmpty	Detemine whether an image data is empty	P.51
	IsUpdated	Detemine whether an image data is updated	P.51
	ClearUpdated	Clear IsUpdated flag	P.51
	Distance	Measure distance	P.51
	InnerProduct	Inner product of two vectors	P.52
	OuterProduct	Outer product of two vectors	P.52
	PutHelp	Set character strings	P.53
Edit			
	Copy	Copy image	P.53
	Cut	Cut image	P.54
	Paste	Paste image	P.54
	Rotate	Rotate image	P.55
	Flip	Flip image	P.56
	Resize	Resize image	P.56
	Split	Split color space	P.57
	Merge	Merge color space	P.58
Filter			
	ConvertGray	Convert to gray scale	P.58
	ThresholdEx	Threshold process	P.59
	Threshold2	Applies fixed-level threshold	P.60
	AdaptiveThresholdEx	Adaptive threshold process	P.61
	Smooth	Smoothing	P.62
	Sobel	Sobel filter	P.63
	Laplace	Laplace filter	P.64
	CannyEx	Canny filter	P.65
	WarpAffine	Affine transformation	P.65
	WarpPerspective	Perspective transformation	P.66
	PreCornerDetectEx	Corner detector	P.68
	CornerHarrisEx	Harris edge detector	P.68
	CalcBackProjectEx	Calculate back projection	P.69
	Inpaint	Inpainting	P.69
	Erode	Erode image	P.70
	Dilate	Dilate image	P. 71

	PyrDown	Down sampling	P.71
	PyrUp	Upsanmpling	P.72
Mask			
	NOT	Bit inversion	P.73
	AND	Logical AND	P.73
	OR	Logical OR	P.74
	XOR	Logical Exclusive OR	P.74
	ADD	Addition	P.75
	SUB	Subtraction	P.75
	MAXEx	Maximum value	P.76
	MINEx	Minimum value	P.76
	ABS	Absolute value	P.77
	LUT	Lookup table translation	P.77
	SetLUT	Set lookup table	P.78
	GetLUT	Get lookup table	P.78
Draw			
	Line	Draw a line (between two specified points)	P.79
	Line2	Draw a line (length specified)	P.79
	Rectangle	Draw a square	P.80
	Circle	Draw a circle	P.81
	Ellipse	Draw an ellipse	P.82
	Sector	Fill eclipse sector	P.83
	Cross	Cross drawing	P.84
	Text	Display character string	P.85
Contours			
	FindContoursEx	Detect contour.	P.86
	CopyContours	Copy contour image	P.87
	ContoursNumber	Retrieve contour ID	P.88
	PointPolygonTest	Check the position relation of a point and a contour	P.88
	BoundingRect	Find a rectangle bounding a contour	P.89
	FitEllipse	Get minimum ellipse bounding the specified contour	P.89
	ArcLength	Get contour boundary length	P.90
	CheckContourConvexity	Check shape convexity	P.90
	DrawContours	Draw contours	P.90
Blob			
	FindBlobs	Find blobs	P.92
	BlobsFilter	Filter the result of FindBlobs	P.92
	BlobResult	Get the blob information by ID	P.95
	BlobResults	Get all blob information	P.95
	BlobEllipse	Get an ellipse fitting the blob	P.96
	BlobMatchTemplate	Detection blob template matching	P.96
	BlobMatchShapes	Detection blob shape matching	P.98
Histogram			
	CalcHistEx	Calculate histogram	P.99
	NormalizeHistEx	Normalize histogram	P.99
	ThreshHistEx	Threshold histogram	P.100
	EqualizeHistEx	Equalize histogram	P.100
	GetMinMaxistValue	Get maximum and minimum value of histogram	P. 100

	HistAve	Calculate average luminance.	P.101
	AutoThreshPTile	Calculate threshold value using P-tile method	P.101
	AutoThreshMode	Calculate threshold value using mode method	P.101
	AutoThreshDiscrim	Calculate threshold value using discrimination analysis method	P.102
Matching			
	MatchTemplate	Template matching	P.102
	MatchShapesEx	Contour matching	P.104
	MatchTemplate2	Extended template matching	P.104
	MatchShapes2	Extended shape matching	P.106
	CamShift	Object tracking	P.108
	HaarDetect	Haar matching	P.109
CARD			
	CARDInit2	Register the template image for CARD	P.109
	CARDRun2	Excute CARD command	P.110
CAL			
	CalibrateCamera	Calibrate camera	P.112
	CalibrateRobot	Calibrate robot	P.113
	FindChessBoardCorners	Find corner of the chessboard	P.114
	DrawChessBoardCorners	Draw the corners of the chessboard	P.115
	DrawXYAxes	Draw XY axis	P.115
	SetCamCalDat	Set calibration data	P.116
	GetCamCalDat	Get calibration data	P.117
	SetCamCalExtDat	Set external variables of camera calibration	P.118
	GetCamCalExtDat	Get external variables of camera calibration	P.119
	ModifyCamCalExtDat	Modify camera calibration external data	P.120
	SetRobCalDat	Set robot calibration data	P.121
	GetRobCalDat	Get robot calibration data	P.122
	SetCameraDescription	Set camera calibration description	P.122
	GetCameraDescription	Get camera calibration description	P.123
	SetRobotDescription	Set robot calibration description	P.123
	GetRobotDescription	Get robot calibration description	P.123
	GetPostFromCam	Convert from camera image coordinate to world coordinate	P.124
	GetCamPos	Convert from world coordinate to camera image coordinate	P.125
	GetPostFromRob	Convert from robot coordinate to world coordinate	P.125
	GetRobPos	Convert from world coordinate to robot coordinate	P.126
	GetRobPosFromCam	Conver from camera image coordinate to robot coordinate	P.126
	GetCamPosFromRob	Conver from robot coordinate to camera image coordinate	P.127
	Undistort2	Image distortion compensation	P.128
Misc.			
	GoodFeatureToTrackEx	Determines corners on image	P.128
	FindCornerSubPixEx	Refine corner detection result	P.129
	MomentsEx	Calculate moment	P.130
	MeasureInfo	Calculate area size, gravity center, and principal axis angle	P.131

HoughLine	Find lines using Hough transform	P.131
HoughCircles	Find circles using Hough transform	P.132
DFTEx	Fourier transform	P.133
IDFT	Inverse Fourier transform	P.133
OpticalFlowEx	Calculate optical flow for two images	P.134
OpticalFlowPyrEx	Optical flow using image pyramid	P.134
BoxPoints	Calculate the four corner positions of the specified rectangular.	P.135
FindHomography	Calculate projection matrix	P.136
QRDecode	Decode several types of two dimensional code such as QRCode	P.137
OCRead	Character recognition	P.137

Table 4-3 Command class command list

Category	Command name	Function	
Triangulation			
	Triangulation	Triangulation	P.138
	TriMatchTemplate	Template matching + Triangulation	P.138
	TriMatchShapes	Shape matching + Triangulation	P.140
	TriHaarDetect	Haar matching + Triangulation	P.142

4.1. Controller class

4.1.1. Video setting

OpenFilterProperty

Format *object*.OpenFilterProperty <Camera ID>, <Window Handle>

Parameters <Camera ID> = VT_I4: Camera ID6
<Window Handle> = VT_I4: Handle to parent or owner window

Return value None

Explanation Open a camera filter property window.

OpenPinProperty

Format *object*.OpenPinProperty(<Camera ID>, <Window Handle>)

Parameters <Camera ID> = VT_I4: Camera ID
<Window Handle> = VT_I4: Handle to parent or owner window

Return value <Format ID> = VT_I4: Camera format ID

Explanation Open an output Pin property window.

SetCtrlMode

Format *object*.SetCtrlMode(<Camera ID>, <Mode>)

Parameters <Camera ID> = VT_I4: Camera ID
<Mode> = VT_I4: Mode

1	VideoControlFlag_FlipHorizontal	Horizontal flip
2	VideoControlFlag_FlipVertical	Vertical flip
4	VideoControlFlag_ExternalTriggerEnable	External trigger enable
8	VideoControlFlag_Trigger	External trigger simulation

Return value None

Explanation Set a video control mode.
Please refer to IAMVideoControl::SetMode() with MSDN for the details.
[Caution] This command may not be executed properly depending on a camera driver

[6] The number 1 to 10 are called 'Camera ID' for convenience.

used.

Related item GetCtrlMode

GetCtrlMode

Format *object*.GetCtrlMode(<CameraID>)

Parameters <CameraID> = VT_I4: Camera ID

Return value <Mode> = VT_I4: Mode

1	VideoControlFlag_FlipHorizontal	Horizontal flip
2	VideoControlFlag_FlipVertical	Vertical flip
4	VideoControlFlag_ExternalTriggerEnable	External trigger enable
8	VideoControlFlag_Trigger	External trigger simulation

Explanation Get a video control mode.

Please refer to IAMVideoControl::SetMode() with MSDN for the details.

[Caution] This command may not be executed properly depending on a camera driver used.

Related item SetCtrlMode

GetRangeCameraCtrl

Format *object*.GetRangeCameraCtrl(<CameraID>, <Property>)

Parameters <CameraID> = VT_I4: Camera ID

<Property> = VT_I4: Property ID

0	CameraControl_Pan	Pan (degree)
1	CameraControl_Tilt	Tile (degree)
2	CameraControl_Roll	Roll (degree)
3	CameraControl_Zoom	Zoom (mm)
4	CameraControl_Exposure	Exposure (2n Sec.)
5	CameraControl_Iris	Iris (fstop * 10)
6	CameraControl_Focus	Focus (mm)

Return value <Min> = VT_I4: Min value

<Max> = VT_I4: Max value

<Step> = VT_I4: Step

<Default> = VT_I4: Default value

<Flag> = VT_I4: Flag

1	CameraControl_Flags_Auto	Automatic Control
2	CameraControl_Flags_Manual	Manual Control

Explanation

Get a parameter range of a camera control.

Please refer to IAMCameraControl::GetRange() with MSDN for the details.

[Caution] This command may not be executed properly depending on a camera driver used.

Related item

GetCameraCtrl, SetCameraCtrl

GetCameraCtrl

Format

object.GetCameraCtrl(<CameraID>, <Property>)

Parameters

<CameraID> = VT_I4: Camear ID

<Property> = VT_I4: Property ID

0	CameraControl_Pan	Pan (degree)
1	CameraControl_Tilt	Tile (degree)
2	CameraControl_Roll	Roll (degree)
3	CameraControl_Zoom	Zoom (mm)
4	CameraControl_Exposure	Exposure (2n Sec.)
5	CameraControl_Iris	Iris (fstop * 10)
6	CameraControl_Focus	Focus (mm)

Return value

<Value> = VT_I4: Value

<Flag> = VT_I4: Flag

1	CameraControl_Flags_Auto	Automatic control
2	CameraControl_Flags_Manual	Manual control

Explanation

Get a parameter of a camera control.

Please refer to IAMCameraControl::Get() with MSDN for the details.

[Caution] This command may not be executed properly depending on a camera driver used.

Related item

GetRangeCameraCtrl, SetCameraCtrl

SetCameraCtrl

Format

object.SetCameraCtrl(<CameraID>, <Property>, <Value>, <Flag>)

Parameters

<CameraID> = VT_I4: Camera ID

<Property> = VT_I4: Property ID

0	CameraControl_Pan	Pan (degree)
1	CameraControl_Tilt	Tile (degree)
2	CameraControl_Roll	Roll (degree)
3	CameraControl_Zoom	Zoom (mm)
4	CameraControl_Exposure	Exposure (2n Sec.)
5	CameraControl_Iris	Iris (fstop * 10)
6	CameraControl_Focus	Focus (mm)

<Value> = VT_I4: Value

<Flag> = VT_I4: Flag

0x001	CameraControl_Flags_Auto	Automatic control
0x002	CameraControl_Flags_Manual	Manual control
0x000	CameraControl_Flags_Absolute	Absolute values
0x010	CameraControl_Flags_Relative	Relative values

Return value

None

Explanation

Set a parameter of a cemara control.

Please refer to IAMCameraControl::Set() with MSDN for the details.

[Caution] This command may not be executed properly depending on a camera driver used.

Related item

GetRangeCameraCtrl, GetCameraCtrl

GetRangeVideoProcAmp

Format

object.GetRangeVideoProcAmp(<CameraID>, <Property>)

Parameters

<CameraID> = VT_I4: Camera ID

<Property> = VT_I4: Property ID

0	VideoProcAmp_Brightness	Brightness
1	VideoProcAmp_Contrast	Contrast (gain * 100)
2	VideoProcAmp_Hue	Hue (degree * 100)
3	VideoProcAmp_Saturation	Saturation
4	VideoProcAmp_Sharpness	Sharpness
5	VideoProcAmp_Gamma	Gamma (gamma * 100)
6	VideoProcAmp_ColorEnable	Color enabled (0: OFF, 1: ON)

7	VideoProcAmp_WhiteBalance	White balance
8	VideoProcAmp_BacklightCompensation	Backlight compensation (0: OFF, 1: ON)
9	VideoProcAmp_Gain	Gain

Return value

<Min> = VT_I4: Min value

<Max> = VT_I4: Max value

<Step> = VT_I4: Step

<Default> = VT_I4: Default value

<Flag> = VT_I4: Flag

1	CameraControl_Flags_Auto	Automatic control
2	CameraControl_Flags_Manual	Manual control

Explanation

Get a parameter range of a video control.

Please refer to IAMVideoProcAmp::GetRange() with MSDN for the details.

[Caution] This command may not be executed properly depending on a camera driver used.

Related item

GetVideoProcAmp, SetVideoProcAmp

GetVideoProcAmp

Format

object.GetVideoProcAmp(<CameraID>, <Property>)

Parameters

<CameraID> = VT_I4: Camera ID

<Property> = VT_I4: Property ID

0	VideoProcAmp_Brightness	Brightness
1	VideoProcAmp_Contrast	Contrast (gain * 100)
2	VideoProcAmp_Hue	Hue (degree * 100)
3	VideoProcAmp_Saturation	Saturation
4	VideoProcAmp_Sharpness	Sharpness
5	VideoProcAmp_Gamma	Gamma (gamma * 100)
6	VideoProcAmp_ColorEnable	Color enabled (0: OFF, 1: ON)
7	VideoProcAmp_WhiteBalance	White balance
8	VideoProcAmp_BacklightCompensation	Backlight compensation (0: OFF, 1: ON)
9	VideoProcAmp_Gain	Gain

Return value **<Value>** = VT_I4: Value

<Flag> = VT_I4: Flag

1	CameraControl_Flags_Auto	Automatic control
2	CameraControl_Flags_Manual	Manual control

Explanation Get a parameter of a video control.

Please refer to IAMVideoProcAmp::Set() with MSDN for the details.

[Caution] This command may not be executed properly depending on a camera driver used.

Related item GetRangeVideoProcAmp, SetVideoProcAmp

SetVideoProcAmp

Format *object*.SetVideoProcAmp(<CameraID>, <Property>, <Value>, <Flag>)

Parameters **<CameraID>** = VT_I4: Camera ID

<Property> = VT_I4: Property ID

0	VideoProcAmp_Brightness	Brightness
1	VideoProcAmp_Contrast	Contrast (gain * 100)
2	VideoProcAmp_Hue	Hue (degree * 100)
3	VideoProcAmp_Saturation	Saturation
4	VideoProcAmp_Sharpness	Sharpness
5	VideoProcAmp_Gamma	Gamma (gamma * 100)
6	VideoProcAmp_ColorEnable	Color enabled (0: OFF, 1: ON)
7	VideoProcAmp_WhiteBalance	White balance
8	VideoProcAmp_BacklightCompensation	Backlight compensation (0: OFF, 1: ON)
9	VideoProcAmp_Gain	Gain

<Value> = VT_I4: Value

<Flag> = VT_I4: Flag

1	CameraControl_Flags_Auto	Automatic control
2	CameraControl_Flags_Manual	Manual control

Return value None

Explanation Set a parameter of a video control.

Please refer to IAMVideoProcAmp::Get() with MSDN for the details.

[Caution] This command may not be executed properly depending on a camera driver

used.

Related item GetRangeVideoProcAmp, GetVideoProcAmp

GetCameraFormatList

Format *object*.GetCameraFormatList(<CameraID>)

Parameters <CameraID> = VT_I4: Camera ID

Return value <Lists> = VT_VARIANT|VT_ARRAY : FormatList (<List1>, <List2>, …)
<Listn> = VT_I4|VT_ARRAY : Format (<Format ID>,<Width>,<Height>)
<Format ID> = VT_I4 : Camera format ID (0～)
<Width> = VT_I4 : X resolution
<Hegiht> = VT_I4 : Y resolution

Explanation Get camera format list.
-1 : Can't use this Format ID.
[Caution] This command may not be executed properly depending on a camera driver used.

Related item GetCameraFormat, SetCameraFormat

GetCameraFormat

Format *object*.GetCameraFormat(<CameraID>)

Parameters <CameraID> = VT_I4 : Camera ID

Return value <Format ID> = VT_I4 : Camera format ID (0～)

Explanation Get camera format ID.
[Caution] Whether this command correctly works is depending on a camera driver.

Related item GetCameraFormatList, SetCameraFormat

SetCameraFormat

Format *object*.SetCameraFormat(<CameraID>, <Format ID>)

Parameters <CameraID> = VT_I4 : Camera ID
<Format ID> = VT_I4 : Camera format ID (0～)

Return value None

Explanation Set camera format ID.
[Caution] Whether this command correctly works is depending on a camera driver.

Related item GetCameraFormatList, GetCameraFormat

ExtExecSoftTrigger

[V1.4.6or later]

Format *object*.ExtExecSoftTrigger(<CameraID>)

Parameters <CameraID> = VT_I4:Camera ID

Return value None

Explanation Execute software trigger of camera.
This command is available only for extended camera.
This command runs "OCV_ExecSoftTrigger" command in CaoController::Execute() on ORiN2 provider which is compatible with extended camera.

ExtRefreshImage

[V1.4.6or later]

Format *object*.ExtRefreshImage(<CameraID>)

Parameters <CameraID> = VT_I4:Camera ID

Return value None

Explanation Update the image of extended camera
This command is available only for extended camera.
This command runs OCV_GetImage command in CaoController::Execute() on ORiN2 provider which is compatible with the extended camera, and then update the internal buffer with obtained image.

ExtInvoke

[V1.4.6 or later]

Format *object*.ExtInvoke(<CameraID>, <Command>, <Parameter>)

Parameters <CameraID> = VT_I4:Camera ID

<Command> = VT_BSTR : Command name
<Parameter> = VT_VARIANT : Parameter

Return value <Result> = VT_VARIANT : Return value

Explanation Execute the command of extended camera
This command is available only for extended camera.
This command runs CaoController::Execute() on ORiN2 provider which is compatible with extended camera.
For the command name that can be specified by <Command>, or the contents of <Parameter> or <Result>, refer to the user's guide of ORiN2 provider corresponding with the extended camera.

ExtConnect

[V1.5.1 or later]

Format *object*.ExtConnect(<CameraID>)

Parameters <CameraID> = VT_I4 : Camera ID

Return value <Connected> = VT_VARIANT : Result

TRUE	Already connected
FALSE	New connection

Explanation Connect with the extended camera specified by <CameraID>
When an extended camera has not been connected, this command connects with an extended camera. The return value is FALSE when it succeeds.
When the specified extended camera has been already connected, this command succeeds without processing. The return value is TRUE.

Related item ExtDisconnect, ExtIsConnected

ExtDisconnect

[V1.5.1 or later]

Format *object*.ExtDisconnect(<CameraID>)

Parameters <CameraID> = VT_I4 : Camera ID

Return value None

Explanation Disconnect the extended camera specified by <CameraID>

This command always succeeds regardless of the connection state with an extended camera.

Related item ExtConnect, ExtIsConnected

ExtIsConnected

[V1.5.1 or later]

Format *object*.ExtIsConnected(<CameraID>)

Parameters <CameraID> = VT_I4:Camera ID

Return value <Result> = VT_VARIANT:Result

TRUE	Communication is possible.
FALSE	Communication is impossible.

Explanation Check the communication state with the extended camera specified by <CameraID>.
This command always succeeds regardless of the connection state with an extended camera. When an extended camera has been connected and the communication is available, this command returns TRUE. FALSE is returned in other status.

Related item ExtConnect, ExtDisconnect

ExtGetConnectOption

[V1.5.2 or later]

Format *object*. ExtGetConnectOption(<CameraID>)

Parameters <CameraID> = VT_I4:Camera ID

Return value <Parameter> = VT_BSTR:Connection Option

Explanation Get extended camera's connection option.

Related item ExtConnect, ExtDisconnect

ExtSetConnectOption

[V1.5.2 or later]

Format *object*. ExtSetConnectOption(<CameraID>, <Parameter>)

Parameters <CameraID> = VT_I4:Camera ID
<Parameter> = VT_BSTR:Connection Option

Return value None

Explanation Set extended camera's connection option.

Related item ExtConnect, ExtDisconnect

4.2. File class

4.2.1. General

SetROI

Format

object.SetROI <ROI>

Parameters

<ROI>= VT_I4|VT_ARRAY:ROI Information (<X>, <Y>, <W>, <H>)

<X> = VT_I4: Start point X coordinates

<Y> = VT_I4: Start point Y coordinates

<W> = VT_I4: Width

<H> = VT_I4: Height

Return value

None

Explanation

Set region of interest(ROI).

After executing this command, the input and result about coordinates depend on <X> and <y>.

Related item

GetROI, ResetROI

Example

[VB6]

```
vntParam = Array(0, 0, 200, 100)
caoFile.Execute "SetROI", vntParam ' Set a ROI (0,0) - (200,100)
```

GetROI

Format

object.GetROI()

Parameters

None

Return value

<ROI>= VT_I4|VT_ARRAY:ROI Information(<X>, <Y>, <W>, <H>)

<X> = VT_I4: Start point X coordinates

<Y> = VT_I4: Start point Y coordinates

<W> = VT_I4: Width

<H> = VT_I4: Height

Explanation

Get value of ROI. VT_EMPTY returns when ROI is not set up.

Related item

SetROI, ResetROI

Example

[VB6]

```
vntRet = caoFile.Execute( "GetROI" ) ' Get current ROI
x = vntRet(0) ' <X>
y = vntRet(1) ' <Y>
```

```
w = vntRet(2) ' <W>
h = vntRet(3) ' <H>
```

ResetROI

Format *object*.ResetROI()

Parameters None

Return value None

Explanation Reset the parameter that set by SetROI command.

Related item SetROI, GetROI

Example [VB6]
caoFile.Execute "ResetROI"

PutColor

Format *object*.PutColor <Output ID>,<X>, <Y>, <R>, <G>, <B>

Parameters <Output ID> = VT_I4: Output Image ID
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates
<R> = VT_I4: Red density
<G> = VT_I4: Green density
<B> = VT_I4: Blue density

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Set color at the specified coordinate point.
For grayscale image, the point is changed to the value of <B>.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item GetColor, SearchPoint

Example [VB6]

```
'Draw a point in red at XY position (100,200) and output it to 101st image.
vntParam = Array(101, 100, 200, 255, 0, 0)
caoFile.Execute "PutColor", vntParam
```

GetColor

Format *object*.GetColor(<X>, <Y>)

Parameters <X> = VT_I4: X coordinates

<Y> = VT_I4: Y coordinates

Return value <Value>= VT_I4 or VT_I4|VT_ARRAY: Color density(<R>, <G>, <B>)

<R> = VT_I4: Red density

<G> = VT_I4: Green density

<B> = VT_I4: Blue density

Explanation Get color at the specified coordinate point.

Color picture: Color density(VT_I4 | VT_ARRAY)

Grayscale picture: Brightness(VT_I4)

Related item PutColor, SearchPoint

Example [VB6]

```
vntParam = Array(100, 200)
' Get the color at XY position (100,200).
vntRet = caoFile.Execute( "GetColor", vntParam )
r = vntRet(0) ' <R>
g = vntRet(1) ' <G>
b = vntRet(2) ' <B>
```

SearchPoint

Format *object*.SearchPoint(<StartX>, <StartY>, <Direction>, <Search value>, <Condition>)

Parameters <StartX> = VT_I4: Start point X coordinate

<StartY> = VT_I4: Start point Y coordinate

<Direction> = VT_I4: Search direction

0	Left
1	Right
2	Up
3	Down

<Search value> = VT_I4: Search value

<Condition> = VT_I4: Search condition

0	equal	[Point data] = <Search value>
1	greater than	[Point data] > <Search value>
2	less than	[Point data] < <Search value>

Return value

<SerchPoint> = VT_I4|VT_ARRAY : Searched coordinate

<X> = VT_I4: Searched X coordinate

<Y> = VT_I4: Searched Y coordinate

Explanation

Search point.

Color image is converted to gray scale before searching.

Returns the first coordinate point that meets the specified condition. When no point meets the condition, (-1, -1) is returned.

Related item

PutColor, GetColor

Example

[VB6]

```
'Search the point with the value of 255 at the right of XY position (10,20).
vntParam = Array(10, 20, 1, 255, 0)
vntRet = caoFile.Execute( "SearchPoint", vntParam )
x = vntRet(0) ' <X>
y = vntRet(1) ' <Y>
```

Trim

Format

object.Trim(<Threshold>, <Condition>)

Parameters

<Threshold> = VT_I4 : Threshold

<Condition> = VT_I4 : Condition

0	greater than	[point data] > <Threshold>
1	less than	[point data] < <Threshold>

Return value

<Area> =VT_I4|VT_ARRAY : Area of trimming

<X> = VT_I4 : X coordinate

<Y> = VT_I4 : Y coordinate

<W> = VT_I4 : Width

<H> = VT_I4 : Height

Explanation

Trim the area which fulfills the argument condition.

Color image is changed to grayscale image.

Return (-1, -1, -1, -1) value when area is wrong..

Related item SearchPoint, SetROI

Example [VB6]

```
' Trim the area with threshold value condition of more than 128.
vntParam = Array(128, 0)
vntRet = caoFile.Execute( "Trim", vntParam )
x = vntRet(0) ' <X>
y = vntRet(1) ' <Y>
w = vntRet(2) ' <W>
h = vntRet(3) ' <H>
```

ImageSize

Format *object*.ImageSize()

Parameters None

Return value <Size> = VT_I4|VT_ARRAY:Size of image.

<W> = VT_I4: Width of image

<H> = VT_I4: Height of image

Explanation Get image size.

Example [VB6]

```
vntRet = caoFile.Execute( "ImageSize" )
w = vntRet(0) ' <W>
h = vntRet(1) ' <H>
```

IsColor

[V1.3.5 or later]

Format *object*.IsColor()

Parameters None

Return value <IsColor> = VT_BOOL : image color

TRUE	Color image
FALSE	Gray scale image

Explanation Determine whther image is colored

IsEmpty

[V1.4.0 or later]

Format *object*.IsEmpty()

Parameters None

Return value <IsEmpty> = VT_BOOL : Empty or not

TRUE	Empty
FALSE	Not empty

Explanation Determine whether an image data is empty.

IsUpdated

[V1.4.0 or later]

Format *object*.IsUpdated ()

Parameters None

Return value <IsUpdated> = VT_BOOL : The state of update of image data.

TRUE	Updated(Default)
FALSE	nonupdated

Explanation Determine whether an image data is updated.
Execute "ClearUpdated" command, in order to change to nonupdate. An initial value is Updated. Please use in combination with "ClearUpdated".

ClearUpdated

[V1.4.0 or later]

Format *object*.ClearUpdated()

Parameters None

Return value None

Explanation Clear the flag of update.

Distance

Format *object*.Distance<Point1>, <Point2>

Parameters <Point1> = VT_I4|VT_ARRAY: Coordinate point 1 (<X>, <Y>, <Z>)
<X> = VT_I4: X coordinate

<Y> = VT_I4: Y coordinate

<Z> = VT_I4: Z coordinate

<Point2> = VT_I4|VT_ARRAY: Coordinate point 2 (<X>, <Y>, <Z>)

<X> = VT_I4: X coordinate

<Y> = VT_I4: Y coordinate

<Z> = VT_I4: Z coordinate

Return value <Distance> = VT_R8: Distance between two points

Explanation Measure the distance between <Point1> and <Point2>.

InnerProduct

Format *object*.InnerProduct <Vector1>, <Vector2>

Parameters <Vector1> = VT_I4|VT_ARRAY: Vector 1 (<X>, <Y>, <Z>)

<X> = VT_I4: X

<Y> = VT_I4: Y

<Z> = VT_I4: Z

<Vector2> = VT_I4|VT_ARRAY: Vector 2 (<X>, <Y>, <Z>)

<X> = VT_I4: X

<Y> = VT_I4: Y

<Z> = VT_I4: Z

Return value <Inner Product> = VT_R8: Inner product

Explanation Calculate the inner product between <Vectore1> and <Vector2>.

OuterProduct

Format *object*.OuterProduct <Vector1>, <Vector2>

Parameters <Vector1> = VT_I4|VT_ARRAY: vector 1 (<X>, <Y>, <Z>)

<X> = VT_I4: X

<Y> = VT_I4: Y

<Z> = VT_I4: Z

<Vector2> = VT_I4|VT_ARRAY: vector 2 (<X>, <Y>, <Z>)

<X> = VT_I4: X

<Y> = VT_I4: Y

<Z> = VT_I4: Z

Return value <Outer product> = VT_R8|VT_ARRAY: Outer product (<X>, <Y>, <Z>)
<X> = VT_I4: X
<Y> = VT_I4: Y
<Z> = VT_I4: Z

Explanation Calculate the outer product between <Vector1> and <Vector2>.

PutHelp

Format *object*.PutHelp <strHelp>

Parameters <strHelp> = VT_BSTR: String

Return value None

Explanation Set a character string that can be obtained by CaoFile::get_Help.
This is not available for the raw image areas.

4.2.2. Edit

Copy

Format *object*.Copy <Output ID>

Parameters <Output ID> = VT_I4: Output Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Copy image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item Cut, Paste

Cut

Format *object*.Cut <Output ID>, <X>, <Y>, <W>, <H>

Parameters <Output ID> = VT_I4: Output Image ID
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates
<W> = VT_I4: Width
<H> = VT_I4: Height

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Cut image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item Copy, Paste

Paste

Format *object*.Paste <Output ID>, <Input ID>, <X>, <Y>

Parameters <Output ID> = VT_I4: Output Image ID
<Input ID> = VT_I4: Putting Image ID
<X> = VT_I4: X Coordinates
<Y> = VT_I4: Y Coordinates

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation The image which be specified by <Input ID> is stuck on the image which be specified by <Output ID>.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bits color bitmap image, and grayscale output format is 8bits

bitmap image.

Related item Copy, Cut

Rotate

Format *object*.Rotate <Output ID>, <X>, <Y>, <Angle>, <Flag>

Parameters <Output ID> = VT_I4: Output Image ID

<X> = VT_I4: X Coordinates

<Y> = VT_I4: Y Coordinates

<Angle> = VT_I4: Rotating angle (degree)

<Flag> = VT_I4: Flag (<Warp>|<Interpolation>)

<Interpolation> =

0	CV_INTER_NN	nearest-neigbor interpolation.
1	CV_INTER_LINEAR	bilinear interpolation.
2	CV_INTER_AREA	resampling using pixel area relation. It is preferred method for image decimation that gives moire-free results. In case of zooming it is similar to CV_INTER_NN method.
3	CV_INTER_CUBIC	bicubic interpolation.

<Warp> =

8	CV_WARP_FILL_OUTLIERS	Fill all the destination image pixels. If some of them correspond to outliers in the source image, they are set to 0.
16	CV_WARP_INVERSE_MAP	Indicates that matrix is inverse transform from destination image to source and, thus, can be used directly for pixel interpolation. Otherwise, the function finds the inverse transform from matrix.

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Rotate image.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard.

Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.
[Note] From Version 1.3.5, rotation dilection is changed to crockwise.

Related item Resize, Flip

Flip

Format *object*.Flip <Output ID>, <Type>

Parameters <Output ID> = VT_I4: Output Image ID
<Type> = VT_I4: Type

0	Flip around Y axis
1	Flip around X axis
2	Flip around both axes

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Flip image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bits color bitmap image, and grayscale output format is 8bits bitmap image.

Related item Resize, Rotate

Resize

Format *object*.Resize <Output ID>, <W>, <H>, <Interpolation>

Parameters <Output ID> = VT_I4: Output Image ID
<W> = VT_I4: Width
<H> = VT_I4: Height
<Interpolation> = VT_I4: Interpolation method

0	CV_INTER_NN	nearest-neigbor interpolation.
1	CV_INTER_LINEAR	bilinear interpolation.
2	CV_INTER_AREA	resampling using pixel area relation. It is preferred

		method for image decimation that gives moire-free results. In case of zooming it is similar to CV_INTER_NN method.
3	CV_INTER_CUBIC	bicubic interpolation.

Return value **<Image>** = VT_UI1|VT_ARRAY: Changed Image

Explanation Resize image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item Rotate, Flip

Split

Format *object*.Split <Output ID(R)>, <Output ID(G)>, <Output ID(B)>

Parameters **<Output ID(R)>** = VT_I4: Red Output Image ID
<Output ID(G)> = VT_I4: GreenOutput Image ID
<Output ID(B)> = VT_I4: Blue Output Image ID

Return value **<Images>** = VT_VARIANT|VT_ARRAY: Splited image
(**<Image(R)>**,**<Image(G)>**,**<Image(B)>**)
<Image(R)> = VT_UI1|VT_ARRAY: Red image
<Image(G)> = VT_UI1|VT_ARRAY: Green image
<Image(B)> = VT_UI1|VT_ARRAY: Blue image

Explanation Separate color image into three elements of RGB, and each element is output to <Output ID(R)>, <Output ID(G)>, <Output ID(B)> respectively as greayscale images. If input image is grayscale, an error is returned.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.

Related item Merge

Merge

Format *object*.Merge <Output ID>, <InputID(R)>, <InputID(G)>, <InputID(B)>

Parameters <Output ID> = VT_I4: Output Image ID
<InputID(R)> = VT_I4: Red Output Image ID
<InputID(G)> = VT_I4: Green Output Image ID
<InputID(B)> = VT_I4: Blue Output Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Merge three gray scale images that correspond to R, G and B components of the color image, and output a color image. The three component images are <InputID(R)>, <InputID(G)>, <InputID(B)> and merged image output is <Output ID>.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 24-bit bitmap file format of the Windows standard.

Related item Split

4.2.3. Filter

ConvertGray

Format *object*.ConvertGray <Output ID>

Parameters <Output ID> = VT_I4: Output Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Convert to gray scale.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.

Example [VB6]

```
caoFile.Execute "ConvertGray", 101 ' Output to the 101st image.
```

ThresholdEx

Format *object*.ThresholdEx <Output ID>, <Threshold>, <Max>, <Mode>

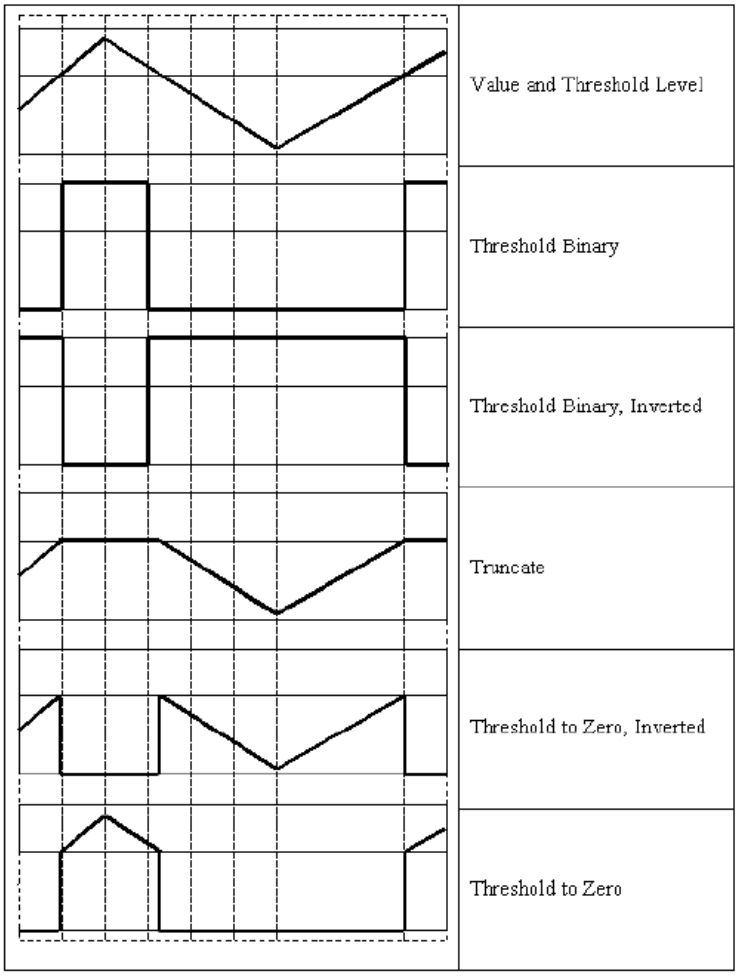
Parameters <Output ID> = VT_I4: Output Image ID

<Threshold> = VT_I4: Threshold

<Max> = VT_I4: Maximum Value

<Mode> = VT_I4: Threshold process type

0	CV_THRESH_BINARY
1	CV_THRESH_BINARY_INV
2	CV_THRESH_TRUNC
3	CV_THRESH_TOZERO
4	CV_THRESH_TOZERO_INV



Return value <Image> = VT_UI1|VT_ARRAY : Changed Image

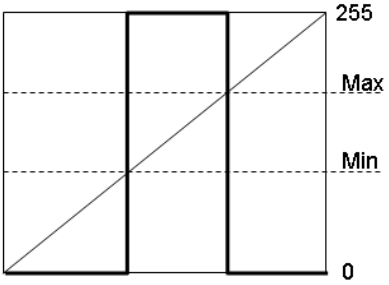
Explanation Threshold process.
Color image is automatically converted to grayscale image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.

Related item Threshold2, AdaptiveThresholdEx

Threshold2

Format *object*.Threshold2 <Output ID>, <Min>, <Max>

Parameters <Output ID> = VT_I4: Output Image ID
<Min> = VT_I4: Lower bound threshold
<Max> = VT_I4: Upper bound threshold



Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Applies fixed-level threshold to array elements.
Color image is automatically converted to grayscale image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.

Related item ThresholdEx, AdaptiveThresholdEx

AdaptiveThresholdEx

Format

object.AdaptiveThresholdEx <Output ID>, <Max value>, <Method>, <Type>, <Block size>, <Parameter>

Parameters

<Output ID> = VT_I4: Output Image ID

<Max value> = VT_I4: Maximum Value

<Method> = VT_I4: Adaptive threshold algorithm type

0	CV_ADAPTIVE_THRESH_MEAN_C
1	CV_ADAPTIVE_THRESH_GAUSSIAN_C

<Type> = VT_I4: Threshold process type

0	CV_THRESH_BINARY
1	CV_THRESH_BINARY_INV

<Block size> = VT_I4: The size of a pixel neighborhood.(3,5,7,…)

<Parameter> = VT_R8: The method-dependent parameter

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Adaptive threshold process.

Color image is automatically converted to grayscale image.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the 8-bit bitmap file format of the Windows standard.

Method option determines threshold calculation method, as shown in the table below.

CV_ADAPTIVE_THRESH_MEAN_C	It is a mean of <Block size> × <Block size> pixel neighborhood, subtracted by <Parameter>.
CV_ADAPTIVE_THRESH_GAUSSIAN_C	It is a weighted sum (gaussian) of <Block size> × <Block size> pixel neighborhood, subtracted by <Parameter>.

Related item

ThresholdEx, Threshold2

Smooth

Format

object.Smooth <Output ID>, <Type>, <Parameter1>, <Parameter2>, <Parameter3>, <Parameter4>

Parameters

<Output ID> = VT_I4: Output Image ID

<Type> = VT_I4: Smoothing type

0	CV_BLUR_NO_SCALE (simple blur with no scaling)	summation over a pixel <Parameter1> × <Parameter2> neighborhood.
1	CV_BLUR (simple blur)	summation over a pixel <Parameter1> × <Parameter2>neighborhood with subsequent scaling by 1/(<Parameter1>・<Pparameter2>).
2	CV_GAUSSIAN (gaussian blur)	convolving image with <Parameter1> × <Parameter2>Gaussian kernel.
3	CV_MEDIAN (median blur)	finding median of <Parameter1> × <Parameter1>neighborhood (i.e. the neighborhood is square).
4	CV_BILATERAL (bilateral filter)	applying bilateral 3x3 filtering with color sigma=<Parameter1>and space sigma=<Parameter2>.

<Parameter1> = VT_I4: Parameter 1

<Parameter2> = VT_I4: Parameter 2

In case of simple scaled/non-scaled and Gaussian blur if <Parameter2> is zero, it is set to <Parameter1>.

<Parameter3> = VT_I4: Parameter 3

In case of Gaussian kernel this parameter may specify Gaussian sigma (standard deviation). If it is zero, it is calculated from the kernel size:

$$\sigma = \left(\frac{n}{2} - 1\right) \times 0.3 + 0.8$$

where n=<Parameter1>for horizontal kernel,

n=<Parameter2>for vertical kernel.

With the standard sigma for small kernels (3×3 to 7×7) the performance is better. If param3 is not zero, while param1 and param2 are zeros, the kernel size is calculated from the sigma (to provide accurate enough operation).

<Parameter4> = VT_I4: Parameter 4

In case of non-square Gaussian kernel the parameter may be used to specify a

different (from param3) sigma in the vertical direction.

Return value **<Image>** = VT_UI1|VT_ARRAY: Changed Image

Explanation Smoothing. Parameters 1-4 have different meanings according to the conversion Type.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.
Smoothing without scaling only supports gray scale images.
Other types of smoothing supports both grascale images and color images.

Sobel

Format *object*.Sobel <Output ID>, <X order>, <Y order>, <Aperture>

Parameters **<Output ID>** = VT_I4: Output Image ID
<X order> = VT_I4: X direction order
<Y order> = VT_I4: Y direction order
<Aperture> = VT_I4: Aperture size
Size of the extended Sobel kernel, must be 1, 3, 5 or 7. In all cases except 1, <Aperture> × <Aperture> separable kernel will be used to calculate the derivative. For aperture_size=1 3x1 or 1x3 kernel is used (Gaussian smoothing is not done). There is also special value CV_SCHARR (=-1) that corresponds to 3x3 Scharr filter that may give more accurate results than 3x3 Sobel. Scharr aperture is:

$$\begin{pmatrix} -3 & 0 & 3 \\ -10 & 0 & 10 \\ -3 & 0 & 3 \end{pmatrix}$$

for x-derivative or transposed for y-derivative.

Return value **<Image>** = VT_UI1|VT_ARRAY: Changed Image

Explanation Sobel filter.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bits color bitmap image, and grayscale output format is 8bit bitmap image.

This command calculates the image derivative by convolving the image with the appropriate kernel:

$$dst(x,y) = \left. \frac{d^{XOrder+YOrder} src}{dx^{XOrder} \cdot dy^{YOrder}} \right|_{(x,y)}$$

Laplace

Format

object.Laplace <Output ID>, <Aperture>

Parameters

<Output ID> = VT_I4: Output Image ID

<Aperture> = VT_I4: Aperture size

Size of the extended Sobel kernel, must be 1, 3, 5 or 7. (it has the same meaning as in Sobel command).

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Laplace filter.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

This command calculates Laplacian of the source image by summing second x- and y-derivatives calculated using Sobel operator:

$$dst(x,y) = \frac{d^2 src}{dx^2} + \frac{d^2 src}{dy^2}$$

Specifying <Aperture>=1 gives the fastest variant that is equal to convolving the image with the following kernel:

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

CannyEx

Format *object*.CannyEx <Output ID>, <Threshold1>, <Threshold2>, <Aperture>

Parameters
<Output ID> = VT_I4: Output Image ID
<Threshold1> = VT_I4: Threshold 1
<Threshold2> = VT_I4: Threshold 2
<Aperture> = VT_I4: Aperture size
Size of the extended Sobel kernel, must be 3, 5 or 7. (it has the same meaning as in Sobel command).

Return value
<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation
Canny filter.
Color image is automatically converted to grayscale image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.
The smallest of <Threshold1> and <Threshold2> is used for edge linking, the largest - to find initial segments of strong edges.

WarpAffine

Format *object*.WarpAffine <Output ID>, <Ax>, <Bx>, <Dx>, <Ay>, <By>, <Dy>, <Flag>

Parameters
<Output ID> = VT_I4: Output Image ID
<Ax> = VT_I4: Affine transformation matrix
<Bx>
<Dx>
<Ay>
<By>
<Dy>

$$\begin{pmatrix} Ax & Bx & Dx \\ Ay & By & Dy \end{pmatrix}$$

<Flag> = VT_I4: Flag (<Warp>|<Interpolation>)
<Interpolation> =

0	CV_INTER_NN	nearest-neigbor interpolation.

1	CV_INTER_LINEAR	bilinear interpolation.
2	CV_INTER_AREA	resampling using pixel area relation. It is preferred method for image decimation that gives moire-free results. In case of zooming it is similar to CV_INTER_NN method.
3	CV_INTER_CUBIC	bicubic interpolation.

<Warp> =

8	CV_WARP_FILL_OUTLIERS	Fill all the destination image pixels. If some of them correspond to outliers in the source image, they are set to 0.
16	CV_WARP_INVERSE_MAP	Indicates that matrix is inverse transform from destination image to source and, thus, can be used directly for pixel interpolation. Otherwise, the function finds the inverse transform from matrix.

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Affine transformation.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

WarpPerspective

Format *object*.WarpPerspective<Output ID>, <Extrinsic matrix>, <Flag>

Parameters <Output ID> = VT_I4 : Output Image ID

<Extrinsic matrix> = VT_R8|VT_ARRAY : Transformation matrix

(<r11>, <r21>, <r31>, <r12>, <r22>, <r32>, <r13>, <r23>, <r33>)

<r11> = VT_R8 :

<r21> = VT_R8 :

<r31> = VT_R8 :

<r12> = VT_R8 :

<r22> = VT_R8:

<r32> = VT_R8:

<r13> = VT_R8:

<r23> = VT_R8:

<r33> = VT_R8:

$$\begin{pmatrix} r11 & r12 & r13 \\ r21 & r22 & r23 \\ r31 & r32 & r33 \end{pmatrix}$$

<Flag> = VT_I4:Flag (<Warp>|<Interpolation>)

<Interpolation> =

0	CV_INTER_NN	nearest-neigbor interpolation.
1	CV_INTER_LINEAR	bilinear interpolation.
2	CV_INTER_AREA	resampling using pixel area relation. It is preferred method for image decimation that gives moire-free results. In case of zooming it is similar to CV_INTER_NN method.
3	CV_INTER_CUBIC	bicubic interpolation.

<Warp> =

8	CV_WARP_FILL_OUTLIERS	Fill all the destination image pixels. If some of them correspond to outliers in the source image, they are set to 0.
16	CV_WARP_INVERSE_MAP	Indicates that matrix is inverse transform from destination image to source and, thus, can be used directly for pixel interpolation. Otherwise, the function finds the inverse transform from matrix.

Return value

<Image> = VT_UI1|VT_ARRAY:Changed Image

Explanation

Calculate perspective transformation.

When output image number is 0, the transformed image is output to return value. When output image number is not 0, the transformed image is output to the specified number ID image, and return value becomes Empty.

The transformed image output data is Windows standard bitmap file format. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

PreCornerDetectEx

Format *object*.PreCornerDetectEx <Output ID>, <Aperture>

Parameters <Output ID> = VT_I4: Output Image ID
<Aperture> = VT_I4: Aperture size
Size of the extended Sobel kernel, must be 3, 5 or 7. (it has the same meaning as in Sobel command).

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Corner detector.
Color image is automatically converted to grayscale image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.
This command calculates the function

$$D_x^2 D_{yy} + D_y^2 D_{xx} - 2D_x D_y D_{xy}$$

where D? denotes one of the first image derivatives and D?? denotes a second image derivative. The corners can be found as local maximums of the function.

CornerHarrisEx

Format *object*.CornerHarrisEx <Output ID>, <Block size>, <Aperture>, <K>

Parameters <Output ID> = VT_I4: Output Image ID
<Block size> = VT_I4: Block size
<Aperture> = VT_I4: Aperture size
Size of the extended Sobel kernel, must be 3, 5 or 7. (it has the same meaning as in Sobel command).
<K> = VT_R8: free variable

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Harris edge detector.
Color image is automatically converted to grayscale image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.

CalcBackProjectEx

Format

object.CalcBackProjectEx <Output ID>, <Input ID>

Parameters

<Output ID> = VT_I4: Output Image ID
<Input ID> = VT_I4: Input image ID

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Calculate back projection.
Creates histogram from input image, and calculate back projection.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.

Inpaint

Format

object.Inpaint <Output ID>, <MaskID>, <Range>, <Flag>

Parameters

<Output ID> = VT_I4: Output Image ID
<MaskID> = VT_I4: Mask Image ID
gray scale. Non-zero pixels indicate the area that needs to be inpainted.
<Range> = VT_I4: Adjacent area
<Flag> = VT_I4: Repair method

0	CV_INPAINT_NS	Navier-Stokes based method.
1	CV_INPAINT_TELEA	The method by Alexandru Telea.

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Repair image.

As for the mask data, the brightness of < MaskID > image is made from the value of one or more.

Color image is automatically converted to grayscale image.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Erode

Format

object.Erode <Output ID>, <Iterations>, <Cols>, <Rows>, <AnchorX>, <AnchorY>, <Shape>

Parameters

<Output ID> = VT_I4: Output image number

<Iterations> = VT_I4: Number of times erosion is applied

<Cols> = VT_I4: Columns of structuring element

<Rows> = VT_I4: Rows of structuring element

<Anchor X> = VT_I4: Horizontal relative offset of anchor point

<Anchor Y> = VT_I4: Vertical relative offset of anchor point

<Shape> = VT_I4: Structuring element shape

0	CV_SHAPE_RECT	A rectangular element
1	CV_SHAPE_CROSS	A cross-shaped element
2	CV_SHAPE_ELLIPSE	An elliptic element

Return value

<Image> = VT_UI1|VT_ARRAY: Converted image

Explanation

Erodes the image using the specified structuring element that determines the shape of a pixel neighborhood over which the minimum is taken

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item Dilate

Dilate

Format *object*.Dilate <Output ID>, <Iterations>, <Cols>, <Rows>, <AnchorX>, <AnchorY>, <Shape>

Parameters <Output ID> = VT_I4: Output image number
<Iterations> = VT_I4: Number of times erosion is applied
<Cols> = VT_I4: Columns of structuring element
<Rows> = VT_I4: Rows of structuring element
<Anchor X> = VT_I4: Horizontal relative offset of anchor point
<Anchor Y> = VT_I4: Vertical relative offset of anchor point
<Shape> = VT_I4: Structuring element shape

0	CV_SHAPE_RECT	A rectangular element
1	CV_SHAPE_CROSS	A cross-shaped element
2	CV_SHAPE_ELLIPSE	An elliptic element

Return value <Image> = VT_UI1|VT_ARRAY: Converted image

Explanation Dilates the image using the specified structuring element that determines the shape of a pixel neighborhood over which the maximum is taken.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item Erode

PyrDown

Format *object*.PyrDown <Output ID>

Parameters <Output ID> = VT_I4: Output image number

Return value <Image> = VT_UI1|VT_ARRAY: Converted image

Explanation Performs downsampling step of Gaussian pyramid decomposition. First it convolves source image with the specified filter and then downsamples the image by rejecting even rows and columns.
The width and height of output image becomes half of input image.
When output image number is 0, transferred image is output to return value.
When output image is not 0, transferred image is output to the specified number, and return value.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item PyrUp

PyrUp

Format *object*.PyrUp <Output ID>

Parameters <Output ID> = VT_I4: Output image number

Return value <Image> = VT_UI1|VT_ARRAY: Converted image

Explanation performs up-sampling step of Gaussian pyramid decomposition. First it upsamples the source image by injecting even zero rows and columns and then convolves result with the specified filter multiplied by 4 for interpolation. So the destination image is four times larger than the source image.
The width and height of output image is doubled from the input image.
When output image number is 0, transferred image is output to return value.
When output image is not 0, transferred image is output to the specified number, and return value.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item PyrDown

4.2.4. Mask

NOT

Format	*object*.NOT <Output ID>
Parameters	<Output ID> = VT_I4: Output Image ID
Return value	<Image> = VT_UI1|VT_ARRAY: Changed Image
Explanation	Bit inversion. If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty. The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.
Related item	AND, OR, XOR, ADD, SUB, MAXEx, MINEx, ABS

AND

Format	*object*.AND <Output ID>, <InputID>
Parameters	<Output ID> = VT_I4: Output Image ID <InputID> = VT_I4: Input Image ID
Return value	<Image> = VT_UI1|VT_ARRAY: Changed Image
Explanation	Logical AND. If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty. The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.
Related item	NOT, OR, XOR, ADD, SUB, MAXEx, MINEx, ABS

OR

Format *object*.OR <Output ID>, <InputID>

Parameters <Output ID> = VT_I4: Output Image ID
<InputID> = VT_I4: Input Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Logical OR.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item NOT, AND, XOR, ADD, SUB, MAXEx, MINEx, ABS

XOR

Format *object*.XOR <Output ID>, <InputID>

Parameters <Output ID> = VT_I4: Output Image ID
<InputID> = VT_I4: Input Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Logical Exclusive-OR.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item NOT, AND, OR, ADD, SUB, MAXEx, MINEx, ABS

ADD

Format *object*.ADD <Output ID>, <InputID>

Parameters <Output ID> = VT_I4: Output Image ID
<InputID> = VT_I4: Input Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Addition.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item NOT, AND, OR, XOR,, SUB, MAXEx, MINEx, ABS

SUB

Format *object*.SUB <Output ID>, <InputID>

Parameters <Output ID> = VT_I4: Output Image ID
<InputID> = VT_I4: Input Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Subtraction.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item NOT, AND, OR, XOR, ADD, MAXEx, MINEx, ABS

MAXEx

Format *object*.MAXEx <Output ID>, <InputID>

Parameters <Output ID> = VT_I4: Output Image ID
<InputID> = VT_I4: Input Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Maximum value.
Color image is automatically converted to grayscale image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item NOT, AND, OR, XOR, ADD, SUB, MINEx, ABS

MINEx

Format *object*.MINEx <Output ID>, <InputID>

Parameters <Output ID> = VT_I4: Output Image ID
<InputID> = VT_I4: Input Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Minimum value.
Color image is automatically converted to grayscale image.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item NOT, AND, OR, XOR, ADD, SUB, MAXEx, ABS

ABS

Format *object*.ABS <Output ID>, <InputID>

Parameters <Output ID> = VT_I4: Output Image ID
<InputID> = VT_I4: Input Image ID

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Absolute value.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item NOT, AND, OR, XOR, ADD, SUB, MAXEx, MINEx

LUT

[V1.3.5 or later]

Format *object*.LUT <Output ID>, <LUT ID>

Parameters <Output ID> = VT_I4: Output Image ID
<LUT ID> = VT_I4 : Lookup table number

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Apply lookup table conversion to <InputID> image, and the converted image is output to <Output ID> or return value.
When <InputID> image is color, each hue is converted using corresponding lookup table.
When <InputID> image is grayscal,e the image is converted using blue hue table.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item SetLUT, GetLUT

SetLUT

[V1.3.5 or later]

Format *object*.SetLUT <LUT ID>, <Table R>, <Table G>, <Table B>

Parameters <LUT ID> = VT_I4: Lookup table number
<Table R> = VT_UI1|VT_ARRAY: Red hue lookup table
<Table G> = VT_UI1|VT_ARRAY: Green hue lookup table
<Table B> = VT_UI1|VT_ARRAY: Blue hue lookup table

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Setup the specified lookup table.
Each hue table requires 256 pixels.
When hue table is not specified and VT_EMPTY is used instead, the table content is not changed.

Related item LUT, GetLUT

GetLUT

[V1.3.5 or later]

Format *object*.GetLUT <LUT ID>

Parameters <LUT ID> = VT_I4: Lookup table number

Return value <LUT> = VT_VARIANT|VT_ARRRAY: Lookup table
(<Table R>, <Table G>, <Table B>)
<Table R> = VT_UI1|VT_ARRAY: Red hue lookup table
<Table G> = VT_UI1|VT_ARRAY: Green hue lookup table
<Table B> = VT_UI1|VT_ARRAY: Blue hue lookup table

Explanation Get the specified lookup table.

Related item LUT, SetLUT

4.2.5. Draw

Line

Format

object.Line <Output ID>, <StartX>, <StartY>, <End X>, <End Y>, <R>, <G>, <B>, <Thick>, <Type>

Parameters

<Output ID> = VT_I4: Output Image ID
<StartX> = VT_I4: Start point X coordinates
<StartY> = VT_I4: Start point Y coordinates
<End X> = VT_I4: End point X coordinates
<End Y> = VT_I4: End point Y coordinates
<R> = VT_I4: Red density
<G> = VT_I4: Green density
<B> = VT_I4: Blue density
<Thick> = VT_I4: Thickness
<Type> = VT_I4: Line type

0,8	8-connected line.
4	4-connected line.
16	antialiased line.

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Draw a line (between two specified points).
For grayscale image, the drawing brightness is set to the value of <B>.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item

Line2

Line2

Format

object.Line2 <Output ID>, <StartX>, <StartY>, <Length>, <Rotate>, <R>, <G>, <B>, <Thick>, <Type>

Parameters

<Output ID> = VT_I4: Output Image ID
<StartX> = VT_I4: Start point X coordinates
<StartY> = VT_I4: Start point Y coordinates
<Length> = VT_I4: Length
<Angle> = VT_I4: Rotating angle (degree)
<R> = VT_I4: Red density
<G> = VT_I4: Green density
<B> = VT_I4: Blue density
<Thick> = VT_I4: Thickness
<Type> = VT_I4: Line type

0,8	8-connected line.
4	4-connected line.
16	antialiased line.

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Draw a line (length specified).
For grayscale image, the drawing brightness is set to the value of <B>.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.
[Note] From Version 1.3.5, rotation dilection is changed to crockwise.

Related item

Line

Rectangle

Format

object.Rectangle <Output ID>, <StartX>, <StartY>, <End X>, <End Y>, <R>, <G>, <B>, <Thick>, <Type>

Parameters

<Output ID> = VT_I4: Output Image ID
<StartX> = VT_I4: Start point X coordinates
<StartY> = VT_I4: Start point Y coordinates
<End X> = VT_I4: End point X coordinates
<End Y> = VT_I4: End point Y coordinates

<R> = VT_I4: Red density

<G> = VT_I4: Green density

<B> = VT_I4: Blue density

<Thick> = VT_I4: Thickness

<Type> = VT_I4: Line type

0,8	8-connected line.
4	4-connected line.
16	antialiased line.

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Draw a rectangle.

For grayscale image, the drawing brightness is set to the value of <B>.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Circle

Format

object.Circle <Output ID>, <X>, <Y>, <Radius>, <R>, <G>, <B>, <Thick>, <Type>

Parameters

<Output ID> = VT_I4: Output Image ID

<X> = VT_I4: center X coordinates

<Y> = VT_I4: center Y coordinates

<Radius> = VT_I4: radius

<R> = VT_I4: red density

<G> = VT_I4: green density

<B> = VT_I4: blue density

<Thick> = VT_I4: thickness

<Type> = VT_I4: line type

0,8	8-connected line.
4	4-connected line.
16	antialiased line.

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Draw a circle.
For grayscale image, the drawing brightness is set to the value of <B>.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Ellipse

Format *object*.Ellipse <Output ID>, <X>, <Y>, <XRadius>, <YRadius>, <Angle>, <Start angle>, <End angle>, <R>, <G>, <B>, <Thick>, <Type>

Parameters <Output ID> = VT_I4: Output Image ID
<X> = VT_I4: Center point X coordinates
<Y> = VT_I4: Center point Y coordinates
<XRadius> = VT_I4: Radius of X axis
<YRadius> = VT_I4: Radius of Y axis
<Angle> = VT_I4: Rotate angle (degree)
<Start angle> = VT_I4: Start angle (degree)
<End angle> = VT_I4: End angle (degree)
<R> = VT_I4: red density
<G> = VT_I4: green density
<B> = VT_I4: blue density
<Thick> = VT_I4: thickness
<Type> = VT_I4: line type

0,8	8-connected line.
4	4-connected line.
16	antialiased line.

Return value <Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation Draw an ellipse.
For grayscale image, the drawing brightness is set to the value of <B>.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0,

the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Please see the Ellipse function in the OpenCV reference for the details.

[Note] From Version 1.3.5, rotation dilection is changed to crockwise..

Sector

Format

object.Sector <Output ID>, <X>, <Y>, <XRadius>, <YRadius>, <Angle>, <Start angle>, <End angle>, <R>, <G>, <B>, <Thick>, <Type>

Parameters

<Output ID> = VT_I4: Output Image ID

<X> = VT_I4: Center point X coordinates

<Y> = VT_I4: Center point Y coordinates

<XRadius> = VT_I4: Radius of X axis

<YRadius> = VT_I4: Radius of Y axis

<Angle> = VT_I4: Rotate angle degree

<Start angle> = VT_I4: Start angle degree

<End angle> = VT_I4: End angle degree

<R> = VT_I4: red density

<G> = VT_I4: green density

<B> = VT_I4: blue density

<Thick> = VT_I4: thickness

<Type> = VT_I4: line type

0,8	8-connected line.
4	4-connected line.
16	antialiased line.

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Fill eclipse sector.

For grayscale image, the drawing brightness is set to the value of <B>.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard.

Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

[Note] From Version 1.3.5, rotation dilection is changed to crockwise.

Cross

Format

object.Cross <Output ID>, <X>, <Y>, <XSize>, <YSize>, <Angle>, <R>, <G>, <B>, <Thick>, <Type>

Parameters

<Output ID> = VT_I4: Output Image ID

<X> = VT_I4: Start point X coordinates

<Y> = VT_I4: Start point Y coordinates

<XSize> = VT_I4: Size of X axis

<YSize> = VT_I4: Size of Y axis

<Angle> = VT_I4: Rotate angle degree

<R> = VT_I4: red density

<G> = VT_I4: green density

<B> = VT_I4: blue density

<Thick> = VT_I4: thickness

<Type> = VT_I4: line type

0,8	8-connected line.
4	4-connected line.
16	antialiased line.

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Cross drawing.

For grayscale image, the drawing brightness is set to the value of <B>.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

[Note] From Version 1.3.5, rotation dilection is changed to crockwise.

Text

Format

object.Text <Output ID>, <X>, <Y>, <Text>, <R>, <G>, <B>, <Font>, <HScale>, <VScale>, <Shear>, <Thick>

Parameters

<Output ID> = VT_I4: Output Image ID

<X> = VT_I4: Start point X coordinates

<Y> = VT_I4: Start point Y coordinates

<Text> = VT_BSTR: Displayed text

<R> = VT_I4: Red density

<G> = VT_I4: Green density

<B> = VT_I4: Blue density

<Font> = VT_I4: Font type

0	CV_FONT_HERSHEY_SIMPLEX	normal size sans-serif font
1	CV_FONT_HERSHEY_PLAIN	small size sans-serif font
2	CV_FONT_HERSHEY_DUPLEX	normal size sans-serif font (more complex than CV_FONT_HERSHEY_SIMPLEX)
3	CV_FONT_HERSHEY_COMPLEX	normal size serif font
4	CV_FONT_HERSHEY_TRIPLEX	normal size serif font (more complex than CV_FONT_HERSHEY_COMPLEX)
5	CV_FONT_HERSHEY_COMPLEX_SMALL	smaller version of CV_FONT_HERSHEY_COMPLEX
6	CV_FONT_HERSHEY_SCRIPT_SIMPLEX	hand-writing style font
7	CV_FONT_HERSHEY_SCRIPT_COMPLEX	more complex variant of CV_FONT_HERSHEY_SCRIPT_SIMPLEX

<HScale> = VT_R8: Width ratio

If equal to 1.0f, the characters have the original width depending on the font type. If equal to 0.5f, the characters are of half the original width.

<VScale> = VT_R8: Height ratio

If equal to 1.0f, the characters have the original height depending on the font type. If equal to 0.5f, the characters are of half the original height.

<Shear> = VT_R8: Relative angle from perpendicular line

Zero value means a non-italic font, 1.0f means ≈45° slope, etc. thickness

Thickness of lines composing letters outlines. The function cvLine is used for drawing letters.

<Thick> = VT_I4: Thickness

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Display character string.

For grayscale image, the drawing brightness is set to the value of <B>.

< Shear > is 0 degrees by 0.0, and 45 degrees by 1.0.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

4.2.6. Contours

FindContoursEx

Format

object.FindContoursEx(<Mode>, <Method>)

Parameters

<Mode> = VT_I4: Retrieval mode

0	CV_RETR_EXTERNAL	retrive only the extreme outer contours
1	CV_RETR_LIST	retrieve all the contours and puts them in the list
2	CV_RETR_CCOMP	retrieve all the contours and organizes them into two-level hierarchy: top level are external boundaries of the components, second level are bounda boundaries of the holes
3	CV_RETR_TREE	retrieve all the contours and reconstructs the full hierarchy of nested contours

<Method> = VT_I4: Approximation method

0	CV_CHAIN_CODE	output contours in the Freeman chain code. All other methods output polygons (sequences of vertices).
1	CV_CHAIN_APPROX_ NONE	translate all the points from the chain code into points;
2	CV_CHAIN_APPROX_S	compress horizontal, vertical, and diagonal

	IMPLE	segments, that is, the function leaves only their ending points;
3	CV_CHAIN_APPROX_TC89_L1	apply one of the flavors of Teh-Chin chain approximation algorithm.
4	CV_CHAIN_APPROX_TC89_KCOS	apply one of the flavors of Teh-Chin chain approximation algorithm.
5	CV_LINK_RUNS	use completely different contour retrieval algorithm via linking of horizontal segments of 1's. Only CV_RETR_LIST retrieval mode can be used with this method.

Return value <Count> = VT_I4: Detection outline number

Explanation Detect contour.
Please refer to the descriptions of FindContours on OpenCV reference for details of the mode and the method.
Color image is automatically converted to grayscale image.
Detected contours are numbered from 0.

CopyContours

Format *object*.CopyContours <Output ID>, <Contour ID>

Parameters <Output ID> = VT_I4: Output memory ID
<Contour ID> = VT_I4: Outline ID

Return value <Image> = VT_UI1|VT_ARRAY: Outline extraction image

Explanation Copy contour image.
If Output Image ID=0, return value is changed image data.
If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image. This command returns error if "FindConoursEx" is not executed beforehand.

Error 0x80101001 : The contours is not detectable.
Please execute the "FindContoursEx" command.

About the another error, please refer to the chapter 2.4.

ContoursNumber

Format *object*.ContoursNumber(<X>, <Y>)

Parameters <X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates

Return value <Contour ID> = VT_I4: Outline ID

Explanation Retrieve Contour ID.
If the specified coordinate does not correspond to Contour ID, 0 is returned.
This command returns error if "FindConoursEx" is not executed beforehand.

Error 0x80101001 : The contours is not detectable.
Please execute the "FindContoursEx" command.
About the another error, please refer to the chapter 2.4.

PointPolygonTest

Format *object*.PointPolygonTest(<Contour ID>, <X>, <Y>, <Measure distance>)

Parameters <Contour ID> = VT_I4: Contour ID
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates
<Measure distance> = VT_I4: Distance measurement flag

0	Don't measure distance
0<>	Measure distance

Return value <Distance> = VT_R8: Measured distance

Explanation Check the position relation of a point and a contour.
If the return value 'Distance' is negative, the point is at the inside of the polygon. If positive, it is at the outside. If 0, the point is on the contour of the polygon.
If Measuring the distance, it means the nearest neighborhood outline.
This command returns error if "FindContoursEx" is not executed beforehand.

Error 0x80101001 : The contours is not detectable.
Please execute the "FindContoursEx" command.

About the another error, please refer to the chapter 2.4.

BoundingRect

Format *object*.BoundingRect(<Contour ID>)

Parameters <Contour ID> = VT_I4: Contour ID

Return value <Rectangle> = VT_I4|VT_ARRAY: Rectangle which connots outline.(<X>, <Y>, <W>, <H>)

<X> = VT_I4: X coordinate of rectangule left up corner

<Y> = VT_I4: Y coordinate of rectangle left up corner

<W> = VT_I4: Width

<H> = VT_I4: Height

Explanation Find a rectangle bounding a contour.

This command returns error if "FindContoursEx" is not executed beforehand.

Error 0x80101001 : The contours is not detectable.
Please execute the "FindContoursEx" command.

About the another error, please refer to the chapter 2.4.

FitEllipse

Format *object*.FitEllipse(<Contour ID>)

Parameters <Contour ID> = VT_I4: Contour ID

Return value <Ellipse> = VT_VARIANT|VT_ARRAY:輪郭にフィットする最良楕円
(<X>,<Y>,<W>,<H>,<Agnle>)

<X> = VT_I4: Center X coordinates

<Y> = VT_I4: Center Y coordinates

<W> = VT_I4: Width

<H> = VT_I4: Height

<Angle> = VT_I4: Rotating angle

Explanation Get minimum ellipse bounding the specified contour.

This command returns error if "FindConoursEx" is not executed beforehand.

[Note] Return value is different from argument of Ellipse.

Error 0x80101001 : Contour is not found. Please execute "FindContoursEx" command.

About another error, please refer to 2.4.

ArcLength

Format *object*.ArcLength(<Contour ID>)

Parameters <Contour ID> = VT_I4: Contour ID

Return value <Length> = VT_R8: Contour boundary length

Explanation Get contour boundary length.

This command returns error if "FindConoursEx" is not executed beforehand.

Error 0x80101001 : Contour is not found. Please execute "FindContoursEx" command.

About another error, please refer to 2.4.

CheckContourConvexity

Format *object*.CheckContourConvexity(<Contour ID>)

Parameters <Contour ID> = VT_I4: Contour ID

Return value <Convexity> = VT_I4: Convexity check result

Explanation Check shape convexity.

If the contour is concave, the return value = 0; if the contour is convex, the return value = 1.

This command returns error if "FindConoursEx" is not executed beforehand.

Error 0x80101001 : Contour is not found. Please execute "FindContoursEx" command.

About another error, please refer to 2.4.

DrawContours

Format *object*.DrawContours <Output ID>, <InputID>, <Contour ID>, <External R>, <External G>, <External B>, <Hole R>, <Hole G>, <Hole B>, <Max level>,

<Thick>, <Type>, <Offset X>, <Offset Y>

Parameters

<Output ID> = VT_I4: output image number

<Input ID> = VT_I4: input image number

<Contour ID> = VT_I4: contour number

<External R> = VT_I4: Red element of external contour

<External G> = VT_I4: Green element of external contour

<External B> = VT_I4: Blue element of external contour

<Hole R> = VT_I4: Red element of internal hole

<Hole G> = VT_I4: Green element of internal hole

<Hole B> = VT_I4: Blue element of internal hole

<Max level> = VT_I4: Maximum level of contour drawing

0	Only contour is drawin.
0 <	Draw outlines with same level as contour, and child outline of contour until the level of abs(max_level)-1.
0 >	Draw child outline of contour until the level of abs(max_level)-1. Outlines with same level as contour is not drawn.

<Thick> = VT_I4: Thickness

<Type> = VT_I4: Line type

<Offset X> = VT_I4: X direction offset

<Offset Y> = VT_I4: Y direction offset

Return value

<Image> = VT_UI1|VT_ARRAY : Draw image

Explanation

Draw external contor or hole (internal) contor of the current image, and the drawn image is output to <Output ID> or the return value.

For grayscale image, the drawing brightness is set to the value of <B>.

When output image number is 0, the drawin image is output as a return value. When output image number is not 0, the drawn image is output the specified number, and returns Empty.

The image is drawn in the Windows standard bitmap file format. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Error

0x80101001 : Contour is not found. Please execute "FindContoursEx" command.

About another error, please refer to 2.4.

4.2.7. Blob

FindBlobs

Format	*object*.FindBlobs(<Mask ID>, <Threshold>, <Moments>)
Parameters	<Mask ID> = VT_I4: Mask image ID <Threshold> = VT_I4: Threshold <Moments> = VT_BOOL: Flag whether it calculates moments or not
Return value	<Count> = VT_I4: Count of blobs
Explanation	Finds blobs. A color-scale image is converted to gray-scale image automatically. If the mask image ID is 0, then masking is not done. If <Moments> is true, then it calculates moment for each blob. Please note this takes more time. Found blobs are numbered from 0. An error is returned when the detected blob number exceeds a limit value (100).
Error	0x80101002 : The detected blob number is over the limit value. About another error, please refer to 2.4.
Related item	BlobsFilter, BlobResult, BlobResults, BlobEllipse, BlobMatchTemplate, BlobMatchShapes

BlobsFilter

Format	*object*.BlobsFilter <Action>, <Evaluador>, <Condition>, <Low Limit>, <High Limit>
Parameters	<Action> = VT_I4: Filter action

0	Include
1	Exclude

<Evaluador> = VT_I4: Evaluation items

0	Area	1	AreaElipseRatio
2	AxisRatio	3	Breadth
4	Compactness	5	DiffX
6	DiffY	7	DistanceFromPoint
8	Elongation	9	Exterior
10	ExternHullPerimeterRatio	11	ExternPerimeter
12	ExternPerimeterRatio	13	HullArea
14	HullPerimeter	15	Length
16	MajorAxisLength	17	MaxX
18	MaxXatMaxY	19	MaxY
20	MaxYatMinX	21	Mean
22	MinorAxisLength	23	MinX
24	MinXatMinY	25	MinY
26	MinYatMaxX	27	Moment
28	Orientation	29	OrientationCos
30	Perimeter	31	Roughness
32	StdDev	33	XCenter
34	XYInside	35	Ycenter

<Condition> = VT_I4: Filter condition

0	Equal	1	Not Equal
2	Greater	3	Less
4	Greater or equal	5	Less or equal
6	Inside	7	Outside

<Low Limit> = VT_I4: Lower bound

<High Limit> = VT_I4: Upper bound

Return value

<Count> = VT_I4: Count of blobs after filtering

Explanation

Filter the blob list retrieved by FindBlobs. If FindBlobs was not done, then error occur. In case of no upper bound, please set 0 to <High Limit>.

Error

0x80101001 : Blob is not found. Please execute "FindContoursEx" command.
About another error, please refer to 2.4.

Related item

FindBlobs

BlobResult

Format

object.BlobResult(<Blob ID>, <Evaluador>, <Parameter1>, <Parameter2>)

Parameters

<Blob ID> = VT_I4: Blob ID

<Evaluador> = VT_I4: Evaluation items

0	Area	1	AreaElipseRatio
2	AxisRatio	3	Breadth
4	Compactness	5	DiffX
6	DiffY	7	DistanceFromPoint
8	Elongation	9	Exterior
10	ExternHullPerimeterRatio	11	ExternPerimeter
12	ExternPerimeterRatio	13	HullArea
14	HullPerimeter	15	Length
16	MajorAxisLength	17	MaxX
18	MaxXatMaxY	19	MaxY
20	MaxYatMinX	21	Mean
22	MinorAxisLength	23	MinX
24	MinXatMinY	25	MinY
26	MinYatMaxX	27	Moment
28	Orientation	29	OrientationCos
30	Perimeter	31	Roughness
32	StdDev	33	XCenter
34	XYInside	35	Ycenter

<Parameter1> = VT_I4: Parameter 1

<Parameter2> = VT_I4: Parameter 2

Return Value

<Value> = VT_I4: Value of the specified item

Explanation

Get value of the specified item from the result of FindBlobs.

Error occurs if this command is called before FindBlobs.

<Parameter1> and <Parameter2> depend on <Evaluador> as follows.

Table 4-4 Parameters of BlobResult

Evluador	Parameter1	Parameter2
7: DistanceFromPoint	X coordinates	Y coordinates
27: Moment	Number of X diff.	Number of Y diff.
34: XYInside	X coordinate	Y coordinate

Others	n/a	n/a

Error 0x80101001 : The blob is not detectable.
Please execute "FindBlobs" command.
About the another error, please refer to the capter 2.4.

Related item FindBlobs

BlobResults

Format *object*.BlobResults(<Blob ID>)

Parameters <Blob ID> = VT_I4: Blob ID

Return value <Result> = VT_VARIANT|VT_ARRAY: Blob result.
(<Label>,<Exterior>,<Perimeter>,<External perimeter>,
<Parent>,<M00>,<M10>,<M01>,<M20>,<M11>,<M02>,
<Min X>,<Max X>,<Min Y>,<Max Y>,<Mean >,<StdDev>)
<Label> = VT_I4: Label of the blob.
<Exterior> = VT_I4: True for extern blobs.
<Perimeter> = VT_R8: Blob perimeter.
<External perimeter> = VT_R8: Amount of blob perimeter which is exterior.
<Parent> = VT_I4: Label of the parent blob.
<M00> = VT_R8: Moments.
<M10>
<M01>
<M20>
<M11>
<M02>
<Min X> = VT_R8: Bounding rect.
<Max X>
<Min Y>
<Max Y>
<Mean> = VT_R8: Mean of the grey scale values of the blob pixels.
<StdDev> = VT_R8: Standard deviation of the grey scale values of the blob pixels.

Explanation Get the results of specified one blob from blob ID.
If FindBlobs was not done, then error occur.

Error 0x80101001 : Blob is not found. Please execute "FindContoursEx" command.
About the another error, please refer to the capter 2.4.

Related item FindBlobs

BlobEllipse

Format *object*.BlobEllipse(<Blob ID>)

Parameters <Blob ID> = VT_I4:Blob ID

Return value <X> = VT_I4: Center X coordinates
<Y> = VT_I4: Center Y coordinates
<W> = VT_I4: Width
<H> = VT_I4Height
<Angle> = VT_I4: Rotating angle

Explanation Get an ellipse fitting the blob.
If FindBlobs was not done, then error occur.

Error 0x80101001 : Blob is not found. Please execute "FindContoursEx" command.
About the another error, please refer to the capter 2.4.

Related item FindBlobs

BlobMatchTemplate

Format *object*.BlobMatchTemplate(<Input ID>, <Method>, <Threshold>, <Start angle>, <End angle>, <Step angle>, <Down sizing>, <Max count>, <Min distance>)

Parameters <Input ID> = VT_I4: Template Image ID
<Method> = VT_I4: Matching method

(I denotes image, T - template, R - result. The summation is done over template and/or the image patch: x'=0..w-1, y'=0..h-1)		
0	CV_TM_SQDIFF	$R(x,y)=\sum_{x',y'}[T(x',y')-I(x+x',y+y')]^2$

1	CV_TM_SQDIFF_NORMED	$R(x,y)=\frac{\sum_{x',y'}[T(x',y')-I(x+x',y+y')]^2}{\sqrt{\sum_{x',y'}T(x',y')^2\cdot\sum_{x',y'}I(x+x',y+y')^2}}$
2	CV_TM_CCORR	$R(x,y)=\sum_{x',y'}[T(x',y')\cdot I(x+x',y+y')]$
3	CV_TM_CCORR_NORMED	$R(x,y)=\frac{\sum_{x',y'}[T(x',y')\cdot I(x+x',y+y')]}{\sqrt{\sum_{x',y'}T(x',y')^2\cdot\sum_{x',y'}I(x+x',y+y')^2}}$
4	CV_TM_CCOEFF	$R(x,y)=\sum_{x',y'}[T'(x',y')\cdot I'(x+x',y+y')]$ where $T'(x',y')=T(x',y')-\frac{\sum_{x'',y''}T(x+x'',y+y'')}{(w\cdot h)}$ $I'(x+x',y+y')=I(x+x',y+y')-\frac{\sum_{x'',y''}I(x+x'',y+y'')}{w\cdot h}$
5	CV_TM_CCOEFF_NORMED	$R(x,y)=\frac{\sum_{x',y'}[T'(x',y')\cdot I'(x+x',y+y')]}{\sqrt{\sum_{x',y'}T'(x',y')^2\cdot\sum_{x',y'}I'(x+x',y+y')^2}}$

<Threshold> = VT_R8: Threshold

<Start angle> = VT_I4: Start angle degree

<End angle> = VT_I4: End angle degree

<Step angle> = VT_I4: Step angle degree

<Down sizing> = VT_I4: Down sizing count

<Max count> = VT_I4: Number of detections

<Min distance> = VT_I4: Minimum distance (0: Same as template image size)

Return value

<Points> = VT_VARIANT|VT_ARRAY: Detected point list

(**<Point1>**, **<Point2>**, …)

<Pointn> = VT_I4|VT_ARRAY : Detected point (**<X>**, **<Y>**, **<Value>**)

<X> = VT_I4: X coordinates

<Y> = VT_I4: Y coordinates

<Angle> = VT_R8: Rotating angle
<Value> = VT_R8: Correlation value

Explanation
Extended template matching between each detected blog and <Input ID> image.
The process same as MatchTemplate2 command is used for extended template matching.
This command returns error before executing FindBlobs command.
[Note] From Version 1.3.5, rotation dilection is changed to crockwise.

Error
0x80101001 : Blob is not found. Please execute "FindContoursEx" command.
About the another error, please refer to the capter 2.4.

Related item
FindBlobs, MatchTemplate2

Hint for high speed search
・ Use BlobsFilter to reduce the number of search target detect Blob number.

BlobMatchShapes

Format
object.BlobMatchShapes(<Input ID>, <Method>, <Min scale>, <Similarity>, <Max count>)

Parameters
<Input ID> = VT_I4: Template Image ID
<Method> = VT_I4: Matching method

A means original image and B means template image in the table below.

0	CV_CONTOUR_MATCH_I1	$I_1(A,B)=\sum_{i=1}^{7}\left\lvert\frac{1}{m_i^A}-\frac{1}{m_i^B}\right\rvert$
1	CV_CONTOUR_MATCH_I2	$I_2(A,B)=\sum_{i=1}^{7}\left\lvert m_i^A-m_i^B\right\rvert$
2	CV_CONTOUR_MATCH_I3	$I_3(A,B)=\sum_{i=1}^{7}\frac{\left\lvert m_i^A-m_i^B\right\rvert}{\left\lvert m_i^A\right\rvert}$

where

$$m_i^A=\sin\left(h_i^A\right)\cdot\log\left(h_i^A\right)$$
$$m_i^B=\sin\left(h_i^B\right)\cdot\log\left(h_i^B\right)$$

h_i^A, h_i^B are Hu moments of A and B, respectively.

<Min scale> = VT_R8: Minimum scale
<Similarity> = VT_R8: Correlation value of contours
<Max count> = VT_I4: Number of detections

Return value
<Points> = VT_VARIANT|VT_ARRAY: Detected point list
(<Point1>, <Point2>, …)
<Pointn> = VT_I4|VT_ARRAY : Detected point (<X>, <Y>, <Value>)
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates
<Angle> = VT_R8: Rotating angle
<Value> = VT_R8: Correlation value

Explanation
Extended template matching between each detected blog and <Input ID> image.
The process same as MatchShapes2 command is used for extended template matching.
This command returns error before executing FindBlobs command.

Error
0x80101001 : Blob is not found. Please execute "FindContoursEx" command.
About the another error, please refer to the capter 2.4.

Related item
FindBlobs, MatchShapes2

4.2.8. Histogram

CalcHistEx

Format
object.CalcHistEx(<Size>)

Parameters
<Size> = VT_I2: Number of elements of histograms

Return value
<Histogram> = VT_R8|VT_ARRAY: Histogram

Explanation
Calculate histogram.
Color image is automatically converted to grayscale image.

Related item
NormalizeHistEx, ThreshHistEx, HistAve, AutoThreshPTile, AutoThreshMode, AutoThreshDiscrim

NormalizeHistEx

Format
object.NormalizeHistEx(<Histogram>, <Factor>)

Parameters <Histogram> = VT_R8|VT_ARRAY: Histogram
<Factor> = VT_R8: Normalization factor

Return value <Histogram> = VT_R8|VT_ARRAY: Histogram

Explanation Normalize histogram.

Related item CalcHistEx

ThreshHistEx

Format *object*.ThreshHistEx(<Histogram>, <Threshold>)

Parameters <Histogram> = VT_R8|VT_ARRAY: Histogram
<Threshold> = VT_R8: Threshold level

Return value <Histogram> = VT_R8|VT_ARRAY: Histogram

Explanation This command clears histogram bins that are below the specified threshold.

Related item CalcHistEx

EqualizeHistEx

Format *object*.EqualizeHistEx <Output ID>

Parameters <Output ID> = VT_I4: Output image ID

Return value <Image> = VT_UI1|VT_ARRAY: Converted image

Explanation The command normalizes brightness and increases contrast of the image.
Color image is automatically converted to grayscale image.
If Output Image ID=0, return value is changed image data.If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.

GetMinMaxHistValue

Format *object*.GetMinMaxHistValue(<Histogram>)

Parameters <Histogram> = VT_R8|VT_ARRAY: Histogram

Return value <Min value> = VT_R4: Minimum value of histogram
<Max value> = VT_R4: Maximum value of histogram
<Min index> = VT_I4: Minimum value of luminance
<Max index> = VT_I4: Maximum value of luminance

Explanation Get maximum and minimum value of histogram.

HistAve

Format *object*.HistAve(<Histogram>)

Parameters <Histogram> = VT_R8|VT_ARRAY: Histogram

Return value <Average> = VT_R4: Average

Explanation Calculate the average of histogram.

Related item CalcHistEx

AutoThreshPTile

Format *object*.AutoThreshPTile(<Histogram>, <Rate>, <Forward>)

Parameters <Histogram> = VT_R8|VT_ARRAY: Histogram
<Rate> = VT_R8: Area rate
<Forward> = VT_BOOL: Search direction

TRUE	Forward search
FALSE	Backward search

Return value <Threshold> = VT_I4: Threshold value

Explanation Calculate the threshold by Percentile Method.

Related item CalcHistEx, AutoThreshMode, AutoThreshDiscrim

AutoThreshMode

Format *object*.AutoThreshMode(<Histogram>)

Parameters <Histogram> = VT_R8|VT_ARRAY: Histogram

Return value <Threshold> = VT_I4: Threshold value

Explanation Calculate the threshold by mode method.

Related item CalcHistEx, AutoThreshPTile, AutoThreshDiscrim

AutoThreshDiscrim

Format *object*.AutoThreshDiscrim(<Histogram>)

Parameters <Histogram> = VT_R8|VT_ARRAY: Histogram

Return value <Threshold> = VT_I4: Threshold value

Explanation Calculate the threshold by discriminant analysis method.

Related item CalcHistEx, AutoThreshMode, AutoThreshPTile

4.2.9. Matching

MatchTemplate

Format *object*.MatchTemplate(<Input ID>, <Method>, <Result points>)

Parameters <Input ID> = VT_I4: Template Image ID

<Method> = VT_I4: Matching method

(I denotes image, T - template, R - result. The summation is done over template and/or the image patch: x'=0..w-1, y'=0..h-1)		
0	CV_TM_SQDIFF	$R(x,y)=\sum_{x',y'}[T(x',y')-I(x+x',y+y')]^2$
1	CV_TM_SQDIFF_NORMED	$R(x,y)=\frac{\sum_{x',y'}[T(x',y')-I(x+x',y+y')]^2}{\sqrt{\sum_{x',y'}T(x',y')^2\cdot\sum_{x',y'}I(x+x',y+y')^2}}$
2	CV_TM_CCORR	$R(x,y)=\sum_{x',y'}[T(x',y')\cdot I(x+x',y+y')]$

3	CV_TM_CCORR_NORMED	$R(x,y)=\frac{\sum_{x',y'}[T(x',y')\cdot I(x+x',y+y')]}{\sqrt{\sum_{x',y'}T(x',y')^2\cdot\sum_{x',y'}I(x+x',y+y')^2}}$
4	CV_TM_CCOEFF	$R(x,y)=\sum_{x',y'}[T'(x',y')\cdot I'(x+x',y+y')]$ where $T'(x',y')=T(x',y')-\frac{\sum_{x'',y''}T(x+x'',y+y'')}{(w\cdot h)}$ $I'(x+x',y+y')=I(x+x',y+y')-\frac{\sum_{x'',y''}I(x+x'',y+y'')}{w\cdot h}$
5	CV_TM_CCOEFF_NORMED	$R(x,y)=\frac{\sum_{x',y'}[T'(x',y')\cdot I'(x+x',y+y')]}{\sqrt{\sum_{x',y'}T'(x',y')^2\cdot\sum_{x',y'}I'(x+x',y+y')^2}}$

<Max count> = VT_I4: Number of detection

Return value

<Points> = VT_VARIANT|VT_ARRAY: Detected point list
(**<Point1>**, **<Point2>**, ···)

<Pointn> = VT_I4|VT_ARRAY : Detected point (**<X>**, **<Y>**, **<Value>**)

<X> = VT_I4: X coordinates

<Y> = VT_I4: Y coordinates

<Value> = VT_R8: Correlation value

Explanation

Template matching. Compares template against overlapped image regions.
Return values are the center point of a detected image which has the highest correlative values up to <Max count>.
[Note] The specification of the auguments and return value were changed from 1.3.1.

Related item

MatchTemplate2, MatchShapesEx, MatchShapes2

Hint for high speed search

・ If the search target image is in a specific area, specify ROI to limit search area for faster search

MatchShapesEx

Format *object*.MatchShapesEx(<Input ID>, <Method>)

Parameters <Input ID> = VT_I4: Template Image ID

<Method> = VT_I4: Matching method

A means original image and B means template image in the table below.

0	CV_CONTOUR_MATCH_I1	$I_1(A,B)=\sum_{i=1}^{7}\left\lvert\frac{1}{m_i^A}-\frac{1}{m_i^B}\right\rvert$
1	CV_CONTOUR_MATCH_I2	$I_2(A,B)=\sum_{i=1}^{7}\left\lvert m_i^A-m_i^B\right\rvert$
2	CV_CONTOUR_MATCH_I3	$I_3(A,B)=\sum_{i=1}^{7}\frac{\left\lvert m_i^A-m_i^B\right\rvert}{\left\lvert m_i^A\right\rvert}$

where

$$m_i^A=\sin(h_i^A)\cdot\log(h_i^A)$$
$$m_i^B=\sin(h_i^B)\cdot\log(h_i^B)$$

h_i^A, h_i^B are Hu moments of A and B, respectively.

Return value <Similarity> = VT_R8: Correlation value of contours

Explanation Compares two shapes.

Perform shape matching between current image and <Input ID> image.

Related item MatchTemplate, MatchTemplate2, MatchShapes2

MatchTemplate2

Format *object*.MatchTemplate2(<Input ID>, <Method>, <Threshold>, <Start angle>, <End angle>, <Step angle>, <Down sizing>, <Max count>, <Min distance>)

Parameters <Input ID> = VT_I4: Template Image ID

<Method> = VT_I4: Matching method

(I denotes image, T - template, R - result. The summation is done over template and/or the image patch: x'=0..w-1, y'=0..h-1)

0	CV_TM_SQDIFF	$R(x,y)=\sum_{x',y'}\left[T(x',y')-I(x+x',y+y')\right]^2$
1	CV_TM_SQDIFF_NORMED	$R(x,y)=\frac{\sum_{x',y'}\left[T(x',y')-I(x+x',y+y')\right]^2}{\sqrt{\sum_{x',y'}T(x',y')^2\cdot\sum_{x',y'}I(x+x',y+y')^2}}$
2	CV_TM_CCORR	$R(x,y)=\sum_{x',y'}\left[T(x',y')\cdot I(x+x',y+y')\right]$
3	CV_TM_CCORR_NORMED	$R(x,y)=\frac{\sum_{x',y'}\left[T(x',y')\cdot I(x+x',y+y')\right]}{\sqrt{\sum_{x',y'}T(x',y')^2\cdot\sum_{x',y'}I(x+x',y+y')^2}}$
4	CV_TM_CCOEFF	$R(x,y)=\sum_{x',y'}\left[T'(x',y')\cdot I'(x+x',y+y')\right]$ where $T'(x',y')=T(x',y')-\frac{\sum_{x'',y''}T(x+x'',y+y'')}{(w\cdot h)}$ $I'(x+x',y+y')=I(x+x',y+y')-\frac{\sum_{x'',y''}I(x+x'',y+y'')}{w\cdot h}$
5	CV_TM_CCOEFF_NORMED	$R(x,y)=\frac{\sum_{x',y'}\left[T'(x',y')\cdot I'(x+x',y+y')\right]}{\sqrt{\sum_{x',y'}T'(x',y')^2\cdot\sum_{x',y'}I'(x+x',y+y')^2}}$

<Threshold> = VT_R8: Threshold

<Start angle> = VT_I4: Start angle degree

<End angle> = VT_I4: End angle degree

<Step angle> = VT_I4: Step angle degree

<Down sizing> = VT_I4: Down sizing count

<Max count> = VT_I4: Number of detections

<Min distance> = VT_I4: Minimum distance (0: Same as template image size)

Return value

<Points> = VT_VARIANT|VT_ARRAY

: Detected point list (**<Point1>**, **<Point2>**, …)

<Pointn> = VT_I4|VT_ARRAY : Detected point (**<X>**, **<Y>**, **<Value>**)

<X> = VT_I4: X coordinates

<Y> = VT_I4: Y coordinates

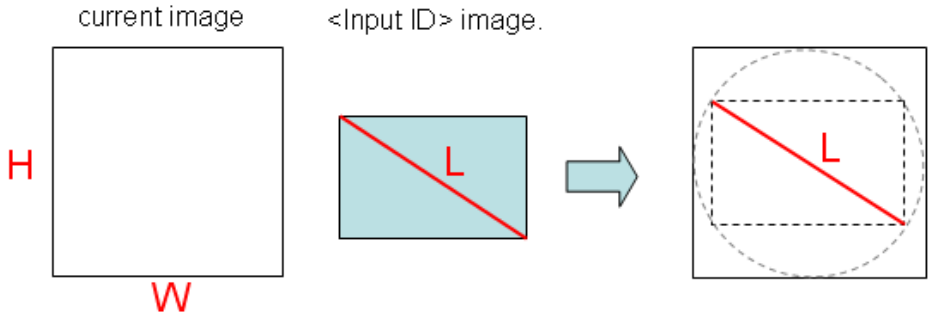
<Angle> = VT_I4: Rotating angle

<Value> = VT_R8: Correlation value

Explanation

Perform extended template matching between current image and <Input ID> image.
Return values are the center point of a detected image which has the highest correlative values up to <Max count>. If correlative value is below <Threshold> or the center point is very near the highest correlative point, then the values are filterd.
When either current image or template image is grayscale, another image is converted to grayscale first, and then template matching is executed.
A current image and <Imput ID> image must statisfy the following conditions.

min(W,H) >= L



[Note]

From Version 1.3.2, the specification of the auguments and return value were changed.

From Version 1.3.5, rotation dilection is changed to crockwise.

Related item

MatchTemplate, MatchShapesEx, MatchShapes2

Hint for high speed search

- If the search target image is in a specific area, specify ROI to limit search area for faster search
- If the rotation angle is in a specific range, appropriately specify the start angle and end angle of matching search.
- To search a round shape, specify start angle and end angle to 0.

MatchShapes2

Format

object.MatchShapes2(<Input ID>, <Method>, <Min scale>, <Similarity>, <Max count>)

Parameters

<Input ID> = VT_I4: Template Image ID

<Method> = VT_I4: Matching method

A means original image and B means template image in the table below.

0	CV_CONTOUR_MATCH_I1	$I_1(A,B)=\sum_{i=1}^{7}\left\lvert\frac{1}{m_i^A}-\frac{1}{m_i^B}\right\rvert$
1	CV_CONTOUR_MATCH_I2	$I_2(A,B)=\sum_{i=1}^{7}\left\lvert m_i^A-m_i^B\right\rvert$
2	CV_CONTOUR_MATCH_I3	$I_3(A,B)=\sum_{i=1}^{7}\frac{\left\lvert m_i^A-m_i^B\right\rvert}{\left\lvert m_i^A\right\rvert}$

where

$$m_i^A=\sin(h_i^A)\cdot\log(h_i^A)$$
$$m_i^B=\sin(h_i^B)\cdot\log(h_i^B)$$

h_i^A, h_i^B are Hu moments of A and B, respectively.

<Min scale> = VT_R8: Minimum scale

<Similarity> = VT_R8: Correlation value of contours

<Max count> = VT_I4: Number of detections

Return value

<Points> = VT_VARIANT|VT_ARRAY: Detected point list

(**<Point1>**, **<Point2>**, …)

<Pointn> = VT_I4|VT_ARRAY : Detected point (**<X>**,**<Y>**,**<Angle>**,**<Similarity >**)

<X> = VT_I4: X coordinates

<Y> = VT_I4: Y coordinates

<Angle> = VT_I4: Rotating angle

<Similarity> = VT_R8: Correlation value of contours

Explanation

Perform the extended shape matching between current image and <Input ID> image.

The shape of the contour extracted from current image is matched with <Input ID> image, and the following information of the minimum ellipse that circumscribes the best matching contour, i.e., center coordinate, rotation angle and contour correlation value.

This function searches from detected contours whose correlation value is less than <Similarity>.

If current image or <Input ID> image is not binary image, contour cannot be correctly detected. Contour is extracted from the white colored part of the binary image. Please use binary images in which search target is white colored.
If two or more cantors are extracted from <Input ID> image, matching may fail. Therefore, <Input ID> image should be selected so that return value of the FindContours for the image is 1.
Small images whose size is less than "size of <Input ID> image" x "<Min scale>" are not searched by this function.
[Note] The specification of the auguments and return value were changed from 1.3.2.

Related item MatchTemplate, MatchTemplate2, MatchShapesEx

CamShift

Format *object*.CamShift(<Position>, <Max loop>, <Precision>)

Parameters
<Position> = VT_I4|VT_ARRAY: Search start position (<X>, <Y>, <W>, <H>)
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates
<W> = VT_I4: Width
<H> = VT_I4: Height
<Max loop> = VT_I4: Number of occurrence
<Precision> = VT_R8: Precision

Return value
<Window> = VT_I4|VT_ARRAY: Detection window (<X>, <Y>, <W>, <H>)
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates
<W> = VT_I4: Width
<H> = VT_I4: Height
<Area> = VT_R8: Sum of all pixels in the search window.
<Rectangle> = VT_I4|VT_ARRAY: Circumscribing rectangle (<X>, <Y>, <W>, <H>, <Angle>)
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates
<W> = VT_I4: Width
<H> = VT_I4: Height
<Angle> = VT_I4: Rotating angle

Explanation Object tracking.

HaarDetect

Format *object*.HaarDetect(<Path>, <Scale>, <MinNeighbors>)

Parameters
<Path> = VT_BSTR: Haar file path
<Scale> = VT_R8: scale
<MinNeighbors> = VT_I4: Minimum neighbors number

Return value
<Points> = VT_VARIANT|VT_ARRAY: Detected point list
(<Point1>, <Point2>, …)
<Pointn> = VT_I4|VT_ARRAY: Detected point (<X>, <Y>, <W>, <H>)
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates
<W> = VT_I4: Width
<H> = VT_I4: Height

Explanation Perform Haar matching to the current image, and return the list of the detected objects. The function return Empty if no object is detected. In this case, the result of the function is S_FALSE.

4.2.10. CARD

CARDInit2

[V1.5.0 or later]

Format *object*.CARDInit(<Input ID>, <X>, <Y>)

Parameters
<Input ID> = VT_I4 : Image ID of the template image.
<X> = VT_I4 : The X coordinate of the detecting point in the template image.
<Y> = VT_I4 : The Y coordinate of the detecting point in the template image.

Return value
<Count> = VT_I4 : The number of the feature points of the template image.

Explanation A template image is registered as initialization of CARD.
For <X> and <Y>, specify two points that are detected as a result of CARDRun2. When -1 is specified, set these points to the center of the template image automatically.
<Count> returns the number of feature points of the template image used by CARDRun2. When you change the template image, please execute this command again.

CARDRun2

[V1.5.0 or later]

Format

object.CARDRun2(<Threshold>, <Count>)

Parameters

<Threshold> = VT_R8 : Threshold value

<Max counts> = VT_I4 : detected number

Return value

<Points> = VT_VARIANT|VT_ARRAY: Detected point list

(<Point1>, <Point2>, …)

<Pointn> = VT_I4|VT_ARRAY : Detected position

(<X>, <Y>, <Angle>, <Scale>, <Value>)

<X> = VT_I4 : X coordinate

<Y> = VT_I4 : Y coordinate

<Angle> = VT_I4 : Rotation angle(degree)

<Scale> = VT_I4 : Scale

<Value> = VT_R8 : Correlation value

Explanation

Execute the image search by CARD.

Execute CARDInit2 before executing this command.

From the detection result by CARD, this command returns points which exceed Threshold value, as the detection result points.

<Max counts> is currently not used. 1 is set at any time.

CARDInitMulti

[V1.5.3 or later]

Format

object.CARDInitMulti(<Input ID>, <X>, <Y>, <Intermediate ID>)

Parameters

<Input ID> = VT_I4 : Image ID of the template image.

<X> = VT_R8 : The X-coordinate of the detecting point in the template image

<Y> = VT_R8 : The Y-coordinate of the detecting point in the template image

<Intermediate ID> = VT_R8 : Output destination ID that stores a processing image at CARD initialization (default:0)

Return value

<Count> = VT_I4 : The number of the feauture points of the template image.

Explanation

A template image is registered as initialization of CARD.

For the template image, specify an image which size is between 2000 pixels and three million pixels.
For <X> and <Y>, specify respective point that will be detected as a execution result of CARDRunMulti.
<Count> returns the number of the feature points of the template image used by CARDRunMulti. To change the template image, execute the command again.
If "0" is specified to <Intermediate ID>, a processing image is not created. If you prefer high-speed operation, set this item to "0".

Error

0x80100005	:	The template image size is too large. Reduce the template image size to three million pixels or less.
0x80101102	:	The template image size is too small. Set the template image size to 2000 pixels or more.

For about other errors, refer to 2.4.

CARDRunMulti

[V1.5.3 or later]

Format

object.CARDRunMulti (<Threshold>, <Count>, <Min distance>, <Intermediate ID>)

Parameters

<Threshold> = VT_R8: Threshold value
<Count> = VT_R8 : Detected number
<Min distance> = VT_I4 : Mininum distance (default : -1)
<Intermediate ID> = VT_R8 : Output destination ID that stores a processing image at CARD detection (default:0)

Return value

<Points> = VT_VARIANT|VT_ARRAY : Detection point list (<Point1>, <Point2>, …)
<Point1> = VT_R8|VT_ARRAY : Detection point
(<X>, <Y>, <Angle>, <Scale>, <Value>)
<X> = VT_R8: X-coordinates
<Y> = VT_R8 : Y-coordinates
<Angle> = VT_R8 : Rotating angle (degree)
<Scale> = VT_R8 : Scale
<Value> = VT_R8 : Correlation value

Explanation

Perform image detection by CARD.
CARDInitMulti needs to be performed before executing this command.

The size of detection target image must be three million pixels or less.
An object whose correlation value is smaller than the value specified by <Threshold> will be excluded from the detection result.
If the distance between the center of detected objects is less than the value specified in <Min distance>, the one with smaller correlation value will be excluded from the searching result, that prevents to count identical object two times or more.
If "-1" is specified to <Min distance>, half the size of width or heights of template image whichever the smaller will be applied. (Example: 640x480 > <Min distance> = 240)
If "0" is specified to <Min distance>, the exclusion based on the distance between objects will not be done.
The detection result will be stored with the decending order of the correlation value.
If there is no detected point, "Empty" will be returned.
If "0" is specified to <Intermediate ID>, a processing image is not created. If you prefer high-speed operation, set this item to "0".

Error

0x80101001	:	CARD is not initilized. Execute CARDInitMulti command
0x80100005	:	The template image size is too large. Reduce the template image size to three million pixels or less.

For about other errors, refer to 2.4.

4.2.11. CAL

CalibrateCamera

Format

object.CalibrateCamera <Input ID>, <Count>, <Square count W>, <Square count H>, <Grid Size>, <Flag>, <Camera CAL ID>

Parameters

<Input ID> = VT_I4: First chessboard image(reference image)
<Count> = VT_I4: Number of chessboard images
<Square count W> = VT_I4: Number of squares (Horizontal)
<Square count H> = VT_I4: Number of squares (Vertical)
<Grid Size> = VT_R8: Grid size
<Flag> = VT_I4: Flag

1	CV_CALIB_CB_ADAPTIVE_THRESH	Use adaptive thresholding to convert the image to black-n-white, rather than a fixed threshold level (computed from the average image brightness).

2	CV_CALIB_CB_NORMALIZE_IMAGE	Normalize the image using cvNormalizeHist before applying fixed or adaptive thresholding.
4	CV_CALIB_CB_FILTER_QUADS	Use additional criteria (like contour area, perimeter, square-like shape) to filter out false quads that are extracted at the contour retrieval stage.

<Camera CAL ID> = VT_I4: Camera calibration ID

Return value: None

Explanation: Calibrate camera parameters.
The function calculates the intrinsic camera parameters from the specified chessboard images, and calculates the extrinsic camera parameters from <Input ID> image.
It requires 5 chessboard images or more. <Square Count> is a number of boxes.
The results are stored in the database automatically.

Related item: FindChessBoardCorners, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, ModifyCamCalExtDat, GetPosFromCam, GetCamPos, GetRobPosFromCam, GetCamPosFromRob, Undistort2

CalibrateRobot

Format: *object*.CalibrateRobot <Robot CAL ID>, <Point1>, <Point2>, <Point3>

Parameters:

<Robot CAL ID> = VT_I4 : Robot calibration ID

<Points> = VT_VARIANT|VT_ARRAY : World – Robot correspondence point list (**<Point1>**, **<Point2>**, …)

<Pointn> = VT_VARIANT |VT_ARRAY : World – Robot correspondence point (**<World Point>**, **<Robot Point>**)

<World Point> = VT_R8 |VT_ARRAY : World coordinate (**<X>**, **<Y>**, **<Z>**)

<X> = VT_R8 : X coordinate

<Y> = VT_R8 : Y coordinate

<Z> = VT_R8 : Z coordinate

<Robot Point> = VT_R8 |VT_ARRAY : Robot coordinate (**<X>**, **<Y>**, **<Z>**)

<X> = VT_R8 : X coordinate

<Y> = VT_R8 : Y coordinate

<Z> = VT_R8 : Z coordinate

Return value None

Explanation Perform robot calibration.
Specify arbitraly numbers of World – Robot coordinate corresponding points, and calculate calibration data.

Related item SetRobCalDat, GetRobCalDat, GetPosFromRob, GetRobPos, GetRobPosFromCam, GetCamPosFromRob

FindChessBoardCorners

Format *object*.FindChessBoardCorners <Square Count W>, <Square Count H>, <Flag>

Parameters <Square Count W> = VT_I4: Number of squares (Horizontal)
<Square Count H> = VT_I4: Number of squares (Vertical)
<Flag> = VT_I4: Flag

1	CV_CALIB_CB_ADAPTIVE_THRESH	Use adaptive thresholding to convert the image to black-n-white, rather than a fixed threshold level (computed from the average image brightness).
2	CV_CALIB_CB_NORMALIZE_IMAGE	Normalize the image using cvNormalizeHist before applying fixed or adaptive thresholding.
4	CV_CALIB_CB_FILTER_QUADS	Use additional criteria (like contour area, perimeter, square-like shape) to filter out false quads that are extracted at the contour retrieval stage.

Return value <Pattern was found> = VT_BOOL: Detection result (0: Fail, <>0: Success)
<Points> = VT_VARIANT|VT_ARRAY: Detected point list
(<Point1>, <Point2>, …)
<Pointn> = VT_I4|VT_ARRAY: Detected point (<X>, <Y>)
<X> = VT_I4: X Coordinate
<Y> = VT_I4: Y Coordinate

Explanation Find corners of chessboard from the image.

Related item CalibrateCamera, DrawChessBoardCorners

DrawChessBoardCorners

Format

object.DrawChessBoardCornersEx <Output ID>, <Square Count W>, <Square Count H>, < Pattern was found > ,<Points>

Parameters

<Output ID> = VT_I4: Output image number

<Square Count W> = VT_I4: Number of squares (Horizontal)

<Square Count H> = VT_I4: Number of squares (Vertical)

<Pattern was found> = VT_BOOL: Detection result

0	Fail
<>0	Success

<Points> = VT_VARIANT|VT_ARRAY : Detected point list

(<Point1>, <Point2>, …)

<Pointn> = VT_I4|VT_ARRAY: Detected point (<X>, <Y>)

<X> = VT_I4: X Coordinate

<Y> = VT_I4: Y Coordinate

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Draw chessboard corner detection result.

If corners are completely detected, colored corners are displayed by connected line. If complete detection was failed, failed corners are shown in red circle.

If Output Image ID=0, return value is changed image data.

If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item

FindChessBoardCorners

DrawXYAxes

Format

object.DrawChessBoardCornersEx <Output ID>, <Camera CAL ID>, <R>, <G> ,<B>

Parameters

<Output ID> = VT_I4: Output image number

<Camera CAL ID> = VT_I4: Camera ID

<R> = VT_I4: Red density

<G> = VT_I4: Green density

<B> = VT_I4: Blue density

Return value

<Image> = VT_UI1|VT_ARRAY: Changed Image

Explanation

Draw X and Y axis which is based on calibration data.

For grayscale image, the drawing brightness is set to the value of <B>.

If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.

Related item

CalibrateCamera

SetCamCalDat

Format

object.SetCamCalDat <Intrinsic matrix>, <Distortion coeffs>, <Extrinsic matrix>, <Camera CAL ID>

Parameters

<Intrinsic matrix> = VT_R8|VT_ARRAY: Internal parameters

(<fx>, <fy>, <cx>, <cy>)

<fx> = VT_R8: Focus distance X

<fy> = VT_R8: Focus distance Y

<cx> = VT_R8: Center coordinate X

<cy> = VT_R8: Center coordinate Y

<Distortion coeffs> = VT_R8|VT_ARRAY: Distortion Coeffs

(<k1>, <k2>, <p1>, <p2>)

<k1> = VT_R8: Distortion coefficients in radius direction

<k2> = VT_R8: Distortion coefficients in radius direction

<p1> = VT_R8: Distortion coefficients in circumference direction

<p2> = VT_R8: Distortion coefficients in circumference direction

<Extrinsic matrix> = VT_R8|VT_ARRAY: External parameters

(<r11>, <r21>, <r31>, <r12>, <r22>, <r32>, <r13>, <r23>, <r33>, <dx>, <dy>, <dz>)

<r11> = VT_R8: Rotation vector

<r21> = VT_R8:

<r31> = VT_R8:

<r12> = VT_R8:

<r22> = VT_R8:

<r32> = VT_R8:

<r13> = VT_R8:

<r23> = VT_R8:

<r33> = VT_R8:

<dx> = VT_R8: Translation motion vector

<dy> = VT_R8:

<dz> = VT_R8:

<Camera CAL ID> = VT_I4: Camera calibration ID

$$s\begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} fx & 0 & cx \\ 0 & fy & cy \\ 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} r11 & r12 & r13 & dx \\ r21 & r22 & r23 & dy \\ r31 & r32 & r33 & dz \end{pmatrix} \times \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix}$$

Return value None

Explanation Set internal and external parameters and distortion coefficients of the camera in database.

Related item CalibrateCamera, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, ModifyCamCalExtDat, GetPosFromCam, GetCamPos, GetRobPosFromCam, GetCamPosFromRob, Undistort2

GetCamCalDat

Format *object*.GetCamCalDat(<Camera CAL ID>)

Parameters <Camera CAL ID> = VT_I4: Camera calibration ID

Return value <Intrinsic matrix> = VT_R8|VT_ARRAY: Internal parameter
(<fx>, <fy>, <cx>, <cy>)

<fx> = VT_R8: Focal length X

<fy> = VT_R8: Focal length Y

<cx> = VT_R8: Center coordinate X

<cy> = VT_R8: Center coordinate Y

<Distortion coeffs> = VT_R8|VT_ARRAY: Distortion coefficients
(<k1>, <k2>, <p1>, <p2>)

<k1> = VT_R8: Radius direction distortion coefficients

<k2> = VT_R8: Radius direction distortion coefficients

<p1> = VT_R8: Circumference direction distortion coefficients

<p2> = VT_R8: Circumference direction distortion coefficients

<Extrinsic matrix> = VT_R8|VT_ARRAY: External parameters

(<r11>, <r21>, <r31>, <r12>, <r22>, <r32>, <r13>, <r23>, <r33>, <dx>, <dy>, <dz>)

<r11> = VT_R8: Rotation vector

<r21> = VT_R8:

<r31> = VT_R8:

<r12> = VT_R8:

<r22> = VT_R8:

<r32> = VT_R8:

<r13> = VT_R8:

<r23> = VT_R8:

<r33> = VT_R8:

<dx> = VT_R8: Translational vector

<dy> = VT_R8:

<dz> = VT_R8:

$$s\begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} fx & 0 & cx \\ 0 & fy & cy \\ 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} r11 & r12 & r13 & dx \\ r21 & r22 & r23 & dy \\ r31 & r32 & r33 & dz \end{pmatrix} \times \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix}$$

Explanation

Get internal and external parameters and distortion coefficients from database.

Related item

CalibrateCamera, SetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, ModifyCamCalExtDat, GetPosFromCam, GetCamPos, GetRobPosFromCam, GetCamPosFromRob, Undistort2

SetCamCalExtDat

Format

object.SetCamCalExtDat <Extrinsic matrix>, <Camera CAL ID>

Parameters

<Extrinsic matrix> = VT_R8|VT_ARRAY: External parameter

(<r11>, <r21>, <r31>, <r12>, <r22>, <r32>, <r13>, <r23>, <r33>, <dx>, <dy>, <dz>)

<r11> = VT_R8: Rotation vector

<r21> = VT_R8:

<r31> = VT_R8:

<r12> = VT_R8:

<r22> = VT_R8:
<r32> = VT_R8:
<r13> = VT_R8:
<r23> = VT_R8:
<r33> = VT_R8:
<dx> = VT_R8: Translational vector
<dy> = VT_R8:
<dz> = VT_R8:
<Camera CAL ID> = VT_I4: Camera calibration ID

$$s\begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} fx & 0 & cx \\ 0 & fy & cy \\ 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} r11 & r12 & r13 & dx \\ r21 & r22 & r23 & dy \\ r31 & r32 & r33 & dz \end{pmatrix} \times \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix}$$

Return value None

Explanation Set external parameters to database

Related item CalibrateCamera, SetCamCalDat, GetCamCalDat, GetCamCalExtDat, ModifyCamCalExtDat, GetPosFromCam, GetCamPos, GetRobPosFromCam, GetCamPosFromRob, Undistort2

GetCamCalExtDat

Format *object*.GetCamCalExtDat(<Inverse>, <Camera CAL ID>)

Parameters <Inverse> = VT_BOOL : Inverse matrix flag

Return value <Extrinsic matrix> = VT_R8|VT_ARRAY: Extrinsic parameter
(<r11>,<r21>,<r31>,<r12>,<r22>,<r32>,<r13>,<r23>,<r33>,<dx>,<dy>,<dz>)
<r11> = VT_R8: Rotation vector
<r21> = VT_R8:
<r31> = VT_R8:
<r12> = VT_R8:
<r22> = VT_R8:
<r32> = VT_R8:
<r13> = VT_R8:
<r23> = VT_R8:
<r33> = VT_R8:

<dx> = VT_R8: Translation vector

<dy> = VT_R8:

<dz> = VT_R8:

<Camera CAL ID> = VT_I4: Camera calibration ID

$$s\begin{pmatrix} u \\ v \\ 1 \end{pmatrix} = \begin{pmatrix} fx & 0 & cx \\ 0 & fy & cy \\ 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} r11 & r12 & r13 & dx \\ r21 & r22 & r23 & dy \\ r31 & r32 & r33 & dz \end{pmatrix} \times \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix}$$

Explanation

Get extrinsic parameters from database.

If <Inverse> is TRUE, inverse of extrinsic matrix is returned.

Related item

CalibrateCamera, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, ModifyCamCalExtDat, GetPosFromCam, GetCamPos, GetRobPosFromCam, GetCamPosFromRob, Undistort2

ModifyCamCalExtDat

Format

object.ModifyCamCalExtDat <Input ID>, <Square count W>, <Square count H>, <Grid Size>, <Flag>, <Camera CAL ID>

Parameters

<Input ID> = VT_I4: Chess board image

<Square Count W> = VT_I4: Number of squares (Horizontal)

<Square Count H> = VT_I4: Number of squares (Vertical)

<Flag> = VT_I4: Flag

1	CV_CALIB_CB_ADAPTIVE_THRESH	Use adaptive thresholding to convert the image to black-n-white, rather than a fixed threshold level (computed from the average image brightness).
2	CV_CALIB_CB_NORMALIZE_IMAGE	Normalize the image using cvNormalizeHist before applying fixed or adaptive thresholding.
4	CV_CALIB_CB_FILTER_QUADS	Use additional criteria (like contour area, perimeter, square-like shape) to filter out false quads that are extracted at the contour retrieval stage.

<Camera CAL ID> = VT_I4: Camera calibration ID

Return value

None

Explanation Update external parameter using the specified image.

Related item CalibrateCamera, FindChessBoardCorners, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, GetPosFromCam, GetCamPos, GetRobPosFromCam, GetCamPosFromRob, Undistort2

SetRobCalDat

Format *object*.SetRobCalDat <Robot CAL ID>, <r11>, <r21>, <r31>, <r12>, <r22>, <r32>, <r13>, <r23>, <r33>, <dx>, <dy>, <dz>

Parameters <Robot CAL ID> = VT_I4 : Robot calibration ID

(<r11>, <r21>, <r31>, <r12>, <r22>, <r32>, <r13>, <r23>, <r33>, <dx>, <dy>, <dz>): Homogeneous translation matrix

<r11> = VT_R8: Rotation Vector

<r21> = VT_R8:

<r31> = VT_R8:

<r12> = VT_R8:

<r22> = VT_R8:

<r32> = VT_R8:

<r13> = VT_R8:

<r23> = VT_R8:

<r33> = VT_R8:

<dx> = VT_R8: Translation Vector

<dy> = VT_R8:

<dz> = VT_R8:

$$\begin{pmatrix} Xr \\ Yr \\ Zr \\ 1 \end{pmatrix} = \begin{pmatrix} r11 & r12 & r13 & dx \\ r21 & r22 & r23 & dy \\ r31 & r32 & r33 & dz \\ 0 & 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} Xw \\ Yw \\ Zw \\ 1 \end{pmatrix}$$

Return value None

Explanation Set robot calibration data to database.

Related item CalibrateRobot, GetRobCalDat, GetPosFromRob, GetRobPos, GetRobPosFromCam, GetCamPosFromRob

GetRobCalDat

Format *object*.GetRobCalDat(<Robot CAL ID>, <Inverse>)

Parameters <Robot CAL ID> = VT_I4 : Robot calibration ID
<Inverse> = VT_BOOL : Inverse matrix flag

Return value <Matrix> = VT_R8|VT_ARRAY: Homogeneous translation matrix
(<r11>, <r21>, <r31>, <r12>, <r22>, <r32>, <r13>, <r23>, <r33>, <dx>, <dy>, <dz>)
<r11> = VT_R8: Rotation Vector
<r21> = VT_R8:
<r31> = VT_R8:
<r12> = VT_R8:
<r22> = VT_R8:
<r32> = VT_R8:
<r13> = VT_R8:
<r23> = VT_R8:
<r33> = VT_R8:
<dx> = VT_R8: Translation Vector
<dy> = VT_R8:
<dz> = VT_R8:

$$\begin{pmatrix} Xr \\ Yr \\ Zr \\ 1 \end{pmatrix} = \begin{pmatrix} r11 & r12 & r13 & dx \\ r21 & r22 & r23 & dy \\ r31 & r32 & r33 & dz \\ 0 & 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} Xw \\ Yw \\ Zw \\ 1 \end{pmatrix}$$

Explanation Get robot calibration data from database.

Related item CalibrateRobot, SetRobCalDat, GetPosFromRob, GetRobPos, GetRobPosFromCam, GetCamPosFromRob

SetCamDescription

Format *object*.SetCamDescription <Camera CAL ID>, <Description>

Parameters <Camera CAL ID> = VT_I4: Camera calibarion ID
<Description> = VT_BSTR : Description

Return value None

Explanation Write camera calibration description into the database.

Related item CalibrateCamera, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, GetCamDescription, GetPosFromCam, GetCamPos, GetRobPosFromCam, GetCamPosFromRob, Undistort2

GetCamDescription

Format *object*.GetCamDescription(<Camera CAL ID>)

Parameters <Camera CAL ID> = VT_I4: Camera calibarion ID

Return value <Description> = VT_BSTR : Description

Explanation Read camera calibration description from the database.

Related item CalibrateCamera, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, SetCamDescription, GetPosFromCam, GetCamPos, GetRobPosFromCam, GetCamPosFromRob, Undistort2

SetRobDescription

Format *object*.SetRobDescription <Robot CAL ID>, <Description>

Parameters <Robot CAL ID> = VT_I4: Robot calibration ID
<Description> = VT_BSTR : Description

Return value None

Explanation Write robot calibration description into the database.

Related item CalibrateRobot, SetRobCalDat, GetRobCalDat, GetRobDescription, GetPosFromRob, GetRobPos, GetRobPosFromCam, GetCamPosFromRob

GetRobDescription

Format *object*.GetRobDescription(<Robot CAL ID>)

Parameters <Robot CAL ID> = VT_I4: Robot calibration ID

Return value **<Description>** = VT_BSTR : Description

Explanation Read robot calibration description from the database.

Related item CalibrateRobot, SetRobCalDat, GetRobCalDat, SetRobDescription, GetPosFromRob, GetRobPos, GetRobPosFromCam, GetCamPosFromRob

GetPosFromCam

Format *object*.GetPosFromCam(<Xc>, <Yc>[, <ZOffset>, <Camera CAL ID>, <Undistort>])

Parameters **<Xc>** = VT_R8: X on camera coordinate
<Yc> = VT_R8: Y on camera coordinate
<ZOffset> =VT_R8: Z on world coordinate
<Camera CAL ID> = VT_I4: Camera calibration ID (Default: 0)
<Undistort> = VT_BOOL : Undistortion(Default: False)

Return value **<Xw>** = VT_R8: X on world coordinate
<Yw> = VT_R8: Y on world coordinate
<Zw> = VT_R8: Z on world coordinate (Same value as Zoffset parameter)

Explanation Convert camera coordinate to world coordinate on the plane where Z=0.
Calibration data of <Camera ID> is used to convert.
When Camera ID=<ZOffset>, following value is used.

Image ID	Used camera ID
Camera(1～10)	Image ID
Not camera(10～)	1

If <Undistort> is TRUE, the command first undistorts the image, and it converts undistorted image coordinate to world coordinate. If <Undistort> is FALSE, the image coordinate is directly converted to world coordinate, without correcting distortion.

Related item CalibrateCamera, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, ModifyCamCalExtDat, GetCamPos, GetRobPosFromCam, Undistort2

GetCamPos

Format *object*.GetCamPos(<Xw>, <Yw>, <Zw>, <Camera CAL ID>)

Parameters
<Xw> = VT_R8: X on world coordinate
<Yw> = VT_R8: Y on world coordinate
<Zw> = VT_R8: Z on world coordinate
<Camera CAL ID> = VT_I4: Camera calibration ID (Default: 0)

Return value
<Xc> = VT_R8: X on camera coordinate
<Yc> = VT_R8: Y on camera coordinate

Explanation
Convert world coordinate to camera coordinate
Calibration data of <Camera ID> is used to convert.
When Camera ID=0, following value is used.

Image ID	Used camera ID
Camera(1～10)	Image ID
Not camera(10～)	1

Related item
CalibrateCamera, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, ModifyCamCalExtDat, GetPosFromCam, GetCamPosFromRob, Undistort2

GetPosFromRob

Format *object*.GetPosFromRob(<Robot CAL ID>, <Xr>, <Yr>, <Zr>)

Parameters
<Robot CAL ID> = VT_I4：Robot calibration ID
<Xr> = VT_R8: X on robot coordinate
<Yr> = VT_R8: Y on robot coordinate
<Zr> = VT_R8: Z on robot coordinate

Return value
<Xw> = VT_R8: X on world coordinate
<Yw> = VT_R8: Y on world coordinate
<Zw> = VT_R8: Z on world coordinate

Explanation
Convert robot coordinate to world coordinate
Calibration data of <Robot ID> is used to convert.

Related item
CalibrateRobot, SetRobCalDat, GetRobCalDat, GetRobPos, GetCamPosFromRob

GetRobPos

Format *object*.GetRobPos(<Robot CAL ID>, <Xw>, <Yw>, <Zw>)

Parameters
<Robot CAL ID> = VT_I4: Robot calibration ID
<Xw> = VT_R8: X on world coordinate
<Yw> = VT_R8: Y on world coordinate
<Zw> = VT_R8: Z on world coordinate

Return value
<Xr> = VT_R8: X on robot coordinate
<Yr> = VT_R8: Y on robot coordinate
<Zr> = VT_R8: Z on robot coordinate

Explanation
Convert world coordinate to robot coordinate.
Calibration data of <Robot ID> is used to convert.

Related item
CalibrateRobot, SetRobCalDat, GetRobCalDat, GetPosFromRob, GetRobPosFromCam

GetRobPosFromCam

Format *object*.GetRobPosFromCam(<Xc>, <Yc> [, <ZOffset>, <Camera CAL ID>, <Robot CAL ID>, <Undistort>])

Parameters
<Xc> = VT_R8: X on camera coordinate
<Yc> = VT_R8: Y on camera coordinate
<ZOffset> =VT_R8: Z on world coordinate
<Camera CAL ID> = VT_I4: Camera calibration ID (Default: 0)
<Robot CAL ID> = VT_I4 : Robot calibration ID(Default:1)
<Undistort> = VT_BOOL : Undistortion(Default: False)

Return value
<Xw> = VT_R8: X on Robot coordinate
<Yw> = VT_R8: Y on Robot coordinate
<Zw> = VT_R8: Z on Robot coordinate (Same value as Zoffset parameter)

Explanation
Convert camera coordinate to robot coordinate as followings.
Camera coordinate → World coordinate → Robot coordinate
Where: when converting camera coordinate to world coordinate, the point is on a Z=<ZOffset> plane.

Calibration data specified by <CameraID> and <RobotID> are used for the conversion.
When Camera ID=0, following value is used.

Image ID	Used camera ID
Camera(1～10)	Image ID
Not camera(10～)	1

Set <Undistort> to TRUE for a distored image.

Related item CalibrateCamera, CalibrateRobot, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, ModifyCamCalExtDat, SetRobCalDat, GetRobCalDat, GetPosFromCam, GetCamPos, GetPosFromRob, GetRobPos, GetCamPosFromRob, Undistort2

GetCamPosFromRob

Format *object*.GetCamPosFromRob(<Xw>, <Yw>, <Zw>[, <Camera CAL ID>, <Robot CAL ID>])

Parameters
<Xw> = VT_R8: X on Robot coordinate
<Yw> = VT_R8: Y on Robot coordinate
<Zw> = VT_R8: Z on Robot coordinate
<Camera CAL ID> = VT_I4: Camera calibration ID (Default: 0)
<Robot CAL ID> = VT_I4：Robot calibration ID(Default:1)

Return value
<Xc> = VT_R8: X on camera coordinate
<Yc> = VT_R8: Y on camera coordinate

Explanation Convert robot coordinate to camera coordinate as followings.
Robot coordinate → World coordinate → Camera coordinate
Calibration data specified by <CameraID> and <RobotID> are used for the conversion.
When Camera ID=0, following value is used.

Image ID	Used camera ID
Camera(1～10)	Image ID
Not camera(10～)	1

Related item CalibrateCamera, CalibrateRobot, SetCamCalDat, GetCamCalDat, SetCamCalExtDat, GetCamCalExtDat, ModifyCamCalExtDat, SetRobCalDat, GetRobCalDat, GetPosFromCam, GetCamPos, GetPosFromRob, GetRobPos, GetRobPosFromCam, Undistort2

Undistort2

Format *object*.Undistort2 <Output ID>, <Camera CAL ID>

Parameters <Output ID> = VT_I4: Output Image ID
<Camera CAL ID> = VT_I4: Camera calibration ID (Default: 0)

Return value <Image> = VT_UI1|VT_ARRAY: Changed image

Explanation Adjust distortion.
If Output Image ID=0, return value is changed image data. If Output Image Id <> 0, the change image is stored in the specified ID image memory, and return value is Empty.
Parameters for the specifed camera ID are used for distortion adjustment.
When Camera ID=0, following value is used.

Image ID	Used camera ID
Camera(1～10)	Image ID
Not camera(10～)	1

The changed image data is output by the bitmap file format of the Windows standard. Color output format is 24bit color bitmap image, and grayscale output format is 8bit bitmap image.
[Note] The specification of the auguments and return value were changed from 1.3.2.

Related item CalibrateCamera, SetCamCalDat, GetCamCalDat

4.2.12. Misc.

GoodFeaturesToTrackEx

Format *object*.GoodFeaturesToTrackEx(<Max count>, <Quality>, <Distance>, <Block size>)

Parameters <Max count> = VT_I4: Maximum number of corner detection
<Quality> = VT_R8: Quality
<Distance> = VT_I4: Minimum distance
<Block size> = VT_I4: Size of the averaged block

Return value <Points> = VT_VARIANT|VT_ARRAY: Detected corners coordinates list
(<Point1>,<Point2>,…)

<Pointn> = VT_I4|VT_ARRAY: Coordinates list (<X>, <Y>)
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates

Explanation The command finds corners with big eigenvalues in the image.

Related item FindCornerSubPixEx

FindCornerSubPixEx

Format *object*.FindCornerSubPixEx(<Points>, <Win X>, <Win Y>, <Zero X>, <Zero Y>, <Term type>, <Max iteration>, <Epsilon>)

Parameters
<Points> = VT_VARIANT|VT_ARRAY: Detected corners coordinates list
<Win X> = VT_I4: X direction half sizes of the search window
<Win Y> = VT_I4: Y direction half sizes of the search window
<Zero X> = VT_I4:
X direction half size of the dead region in the middle of the search zone
<Zero Y> = VT_I4:
Y direction half size of the dead region in the middle of the search zone
<Term type> = VT_I4: Repetition end condition type

1	Periodic duty
2	Precision attained use

<Max teration> = VT_I4: Maximum number of occurrences
<Epsilon> = VT_R8: Precision attained

Return value
<Points> = VT_VARIANT|VT_ARRAY: Detected corners coordinates list
(<Point1>, <Point2>, …)
<Pointn> = VT_I4|VT_ARRAY: Coordinates list (<X>, <Y>)
<X> = VT_I4: X coordinates
<Y> = VT_I4: Y coordinates

Explanation Refine corner detection result.
The result of command DetermineCorners is used for Points of the parameter.
The size of the retrieval area and the exclusion area should specify half the size of the target.

Related item GoodFeaturesToTrackEx

MomentsEx

Format *object*.MomentsEx(<Contour ID>)

Parameters <Contour ID> = VT_I4: Contour ID

-1	The entire screen
<>-1	The specified contour

Return value <Moments> = VT_VARIANT|VT_ARRAY: Moment
(<SpatialMoments>,<CentralMoments>,<inv_sqrt_m00>)
<Spatial moments> = VT_R8|VT_ARRAY: Spatial moments
<M00> = VT_R8:
<M10> = VT_R8:
<M01> = VT_R8:
<M20> = VT_R8:
<M11> = VT_R8:
<M02> = VT_R8:
<M30> = VT_R8:
<M21> = VT_R8:
<M12> = VT_R8:
<M03> = VT_R8:
<Central moments> = VT_R8|VT_ARRAY: Central moments
<M20> = VT_R8:
<M11> = VT_R8:
<M02> = VT_R8:
<M30> = VT_R8:
<M21> = VT_R8:
<M12> = VT_R8:
<M03> = VT_R8:
<inv_sqrt_m00> = VT_R8:1/sqrt(M00)

Explanation Calculate moment.
Execute command FindContoursEx beforehand when you specify Contour ID.
Color image is automatically converted to grayscale image.

Error 0x80101001 : Contour is not found. Please execute "FindContoursEx" command.
About the another error, please refer to the capter 2.4.

MeasureInfo

Format *object*.MeasureInfo(<Moments>)

Parameters <Moments> = VT_R8|VT_ARRAY: Moment
<M00> = VT_R8:
<M10> = VT_R8:
<M01> = VT_R8:
<M20> = VT_R8:
<M11> = VT_R8:
<M02> = VT_R8:

Return value <Area> = VT_R8: Area
<Center of gravity X> = VT_R8: Center of gravity point X coordinates
<Center of gravity Y> = VT_R8: Center of gravity point Y coordinates
<Principal axis angle> = VT_R8: Principal axis angle

Explanation Calculate area size, gravity center, and principal axis angle.
Specify the execution result of MomentsEx command for Moments argument.
Please refer to the descriptions of MeasureInfo on OpenCV reference for details of the mode and the method.

HoughLines

Format *object*.HoughLines(<Method>, <Rho>, <Theta>, <Threshold>, <Para1>, <Para2>)

Parameters <Method> = VT_I4: The Hough transform variant

0	CV_HOUGH_STANDARD	classical or standard Hough transform. Every line is represented by two floating-point numbers (ρ, θ), where ρ is a distance between (0,0) point and the line, and θ is the angle between x-axis and the normal to the line.
1	CV_HOUGH_PROBABILISTIC	probabilistic Hough transform (more efficient in case if picture contains a few long linear segments). It returns line segments rather than the whole lines. Every

		segment is represented by starting and ending points.
2	CV_HOUGH_MULTI_SCALE	multi-scale variant of classical Hough transform. The lines are encoded the same way as in CV_HOUGH_STANDARD.

<Rho> = VT_R8: ρ (Rho)
<Theta> = VT_R8: θ (Theta)
<Threshold> = VT_I4: Threshold
<Para1> = VT_R8: Parameter1
<Para2> = VT_R8: Parameter2

Return value

<Lines> = VT_VARIANT|VT_ARRAY : Straight line detection result list
(<Line1>, <Line2>, …)
<Linen> = VT_I4|ARRAY : Straight line list
(<StartX>,<StartY>,<End X>,<End Y>)
<StartX> = VT_I4: Start X-Coordinates
<StartY> = VT_I4: Start Y-Coordinates
<End X> = VT_I4: End X-Coordinates
<End Y> = VT_I4: End Y-Coordinates

Explanation

Find lines using Hough transform.

Related item

HoughCircles

HoughCircles

Format

object.HoughCircles(<dp>, <Min distance>, <Canny threshold>, <Center threshold>, <Min radius>, <Max radius>)

Parameters

<dp> = VT_R8: Calculation resolution
<Min distance> = VT_R8: Minimum distance between center coordinate
<Canny threshold> = VT_R8: Higher threshold used in Canny
<Center threshold> = VT_R8: Center detection calculation threshold
<MinRadius> = VT_I4: Minimum radius
<MaxRadius> = VT_I4: Maximum radius

Return value

<Circles> = VT_VARIANT|VT_ARRAY : Detected circle list
(<Circle1>, <Circle2>, …)
<Circlen> = VT_R4|VT_ARRAY: Circle (<CenterX>,<CenterY>,<Radius>)

<CenterX> = VT_R4: Center X coordinates
<CenterY> = VT_R4: Center Y coordinates
<Radius> = VT_R4: Radius

Explanation Find circles using Hough transform.

Related item HoughLines

DFTEx

Format *object*.DFTEx <Output ID>, <Output ID(R)>, <Output ID(I)>

Parameters <Output ID> = VT_I4: Output image ID
<Output ID(R)> = VT_I4: Output real part image ID
<Output ID(I)> = VT_I4: Output imaginary part image ID

Return value <Image> = VT_UI1|VT_ARRAY: Converted image

Explanation Perform DFT(Discrete Fourier Transform).
If <Output ID> is 0, then the transformed image is returned. If <Output ID> is not 0, then the transformed image is stored in the specified image memory area, and VT_EMPTY is returned.
The database area can not be used as <Real image ID> or <Imaginary Image ID>. Use memory area instead.
A color-scale image is converted to the gray-scale image automatically.
The changed image data is output by the 8-bit bitmap file format of the Windows standard.

Related item IDFT

IDFT

Format *object*.IDFT <Output ID>, <Input ID(R)>, <Input ID(I)>

Parameters <Output ID> = VT_I4: Output image ID
<Input ID(R)> = VT_I4: Input real part image ID
<Input ID(I)> = VT_I4: Input imaginary part image ID

Return value <Image> = VT_UI1|VT_ARRAY: Converted image

Explanation

Perform Inverse DFT(Discrete Fourier Transform).

If <Output ID> is 0, then the transformed image is returned. If <Output ID> is not 0, then the transformed image is stored in the specified image memory area, and VT_EMPTY is returned.

The changed image data is output by the 8-bit bitmap file format of the Windows standard.

Related item

DFTEx

OpticalFlowEx

Format

object.OpticalFlowEx(<Input ID>, <X size>, <Y size>)

Parameters

<Input ID> = VT_I4: Comparison image ID

<X size> = VT_I4: Unit of X axis measurement

<Y size> = VT_I4: Unit of Y axis measurement

Return value

<Points> = VT_VARIANT|VT_ARRAY : Point result list

(<Point1>, <Point2>, …)

<Pointn> = VT_I4|VT_ARRAY: Position and Variation (<X>, <Y>, <dX>, <dY>)

<X> = VT_I4: X-Coordinates

<Y> = VT_I4: Y-Coordinates

<dX> = VT_I4: X variation

<dY> = VT_I4: Y variation

Explanation

Perform OpticalFlowEx process between the current image and <Input ID> image, and return the point list.

For details, please refer to CalcOpticalFlowLK of OpenCV reference.

OpticalFlowPyrEx

Format

object.OpticalFlowPyrEx(<Input ID>, <Points>, <Win X>, <Win Y>, <Level>)

Parameters

<Input ID> = VT_I4: comparison image number

<Points> = VT_VARIANT|VT_ARRAY: search point list

(<Point1>, <Point2>, …)

<World Point> = VT_R8 |VT_ARRAY : search point coordinate(<X>, <Y>)

<X> = VT_R8: X coordinate

<Y> = VT_R8: Y coordinate

<Win X> = VT_I4: search window size (X)

<Win Y> = VT_I4: search window size (Y)

<Level> = VT_I4: Pyramid level maximum value

0	Pyramid not used (single level). Level is set to 2
1	Set pyramid level to 2
>2	Specified value is set to the maximum level of pyramid.

Return value

<Points> = VT_VARIANT|VT_ARRAY: point list (<Point1>, <Point2>, …)

<Pointn> = VT_I4|VT_ARRAY: point after move (<X>, <Y>)

<X> = VT_I4: X coordinate

<Y> = VT_I4: Ycoordinate

Explanation

Calculates optical flow for a sparse feature set using iterative Lucas-Kanade method in pyramids.

The function CalcOpticalFlowPyrLK calculates the optical flow between two images for the given set of points in <Input ID> image. The function finds the flow with sub-pixel accuracy.

For details, please refer to cvCalcOpticalFlowPyrLK of OpenCV reference.

BoxPoints

Format

object.BoxPoints(<X>, <Y>, <W>, <H>, <Angle>)

Parameters

<X> = VT_I4: Center X coordinates

<Y> = VT_I4: Center Y coordinates

<W> = VT_I4: Width

<H> = VT_I4: Height

<Angle> = VT_I4: Rotating angle

Return value

<Points> = VT_VARIANT|VT_ARRAY: Four corner point list (<Point1>, <Point2>, <Point3>, <Point4>)

<Pointn> = VT_I4|VT_ARRAY: Position (<X>, <Y>)

<X> = VT_I4: X-Coordinates

<Y> = VT_I4: Y-Coordinates

Explanation

Calculate the four corner point coordinate of the specified rectangular.

[Note] From Version 1.3.5, rotation dilection is changed to crockwise..

FindHomography

Format

object.FindHomography(<Point1>, <Point2>, <Point3>)

Parameters

<Points> = VT_VARIANT|VT_ARRAY:

Projection transformation corresponding point list (<Point1>, <Point2>, …)

<Pointn> = VT_VARIANT |VT_ARRAY:

Corresponding points before and after the projection transformation

(<Before Point>,<After Point>)

<Before Point> = VT_R8 |VT_ARRAY : Point before transformation(<X>, <Y>)

<X> = VT_R8: X coordinate

<Y> = VT_R8: Y coordinate

<After Point> = VT_R8 |VT_ARRAY : Point after transformation (<X>, <Y>)

<X> = VT_R8: X coordinate

<Y> = VT_R8: Y coordinate

Return value

<Matrix> = VT_R8|VT_ARRAY : Homography matrix

(<r11>, <r12>, <r13>, <r21>, <r22>, <r23>, <r31>, <r32>, <r33>)

<r11> = VT_R8 :

<r12> = VT_R8 :

<r13> = VT_R8 :

<r21> = VT_R8 :

<r22> = VT_R8 :

<r23> = VT_R8 :

<r31> = VT_R8 :

<r32> = VT_R8 :

<r33> = VT_R8 :

$$\begin{pmatrix} r11 & r12 & r13 \\ r21 & r22 & r23 \\ r31 & r32 & r33 \end{pmatrix}$$

Explanation

Calculate projection transformation matrix.

Specify arbitrary numbers of corresponding points for projection transformation, and calculate projection transformation matrix.

Related item

WarpPerspective

QRDecode

Format *object*.QRDecode(<Code>)

Parameters <Code> = Code type

0	CODE_QR	Decode QR code Model 1 or Model 2
1	CODE_MICROQR	Decode Micro QR
2	CODE_DATAMATRIX	Decode DataMatrix
3	CODE_PDF417	Decode PDF417
4	CODE_BARCODE	Decode barcode () (UPC/EAN， CODE39， CODABAR(NW-7)，Interleaved 2 of 5(ITF), CODE128, EAN-128, RSS)をデコード
5	CODE_MICROPDF	Decode MicroPDF417
6	CODE_COMPOSITE	Decode EAN.UCC Composite

Return value <Data> = VT_BSTR: Decoded data

<Decode info> = VT_VARIANT|VT_ARRAY: Information about decoding

Explanation Decode several types of two dimensional code such as QRCode.

Please see the <Code> and <Decode info>information in the QRdecoder manual for the details.

Error 0x80101001 : QR Decoder is not initialized. Please use "Qrnabled=True" Option in AddController..

About the another error, please refer to the capter 2.4.

OCRead

Format *object*.OCRead()

Parameters None

Return value <Data> = VT_BSTR: recognized string

Explanation Recognize a character string from image. But only an alphanumeric character string is recognizable.

The image should be converted to binary image to improve recognition.

Error 0x80101001 : OCR is not initialized. Please use "OCREnabled=True " Option in AddController..

About the another error, please refer to the capter 2.4.

4.3. Command class

4.3.1. Triangulation

Triangulation

Format *object*.Triangulation(<Camera1 CAL ID>, <Camera2 CAL ID>, <Camera3 CAL ID>, <Xc1>, <Yc1>, <Xc2>, <Yc2>, <Xc3>, <Yc3>, <Tru-Method>)

Parameters
<Camera1 CAL ID> = VT_I4: Camera 1 calibration number
<Camera2 CAL ID> = VT_I4: Camera 2 calibration number
<Camera3 CAL ID> = VT_I4: Camera 3 calibration number(0: Not used)
<Xc1> = VT_R8: Camera 1 X coordinate
<Yc1> = VT_R8: Camera 1 Y coordinate
<Xc2> = VT_R8: Camera 2 X coordinate
<Yc2> = VT_R8: Camera 2 Y coordinate
<Xc3> = VT_R8: Camera 3 X coordinate
<Yc3> = VT_R8: Camera 3 Y coordinate
<Tru-Method> = VT_I4: Triangulation method

0	Liner	Singular value analysis
1	Midpoint	Center point analysis

Return value
<X> = VT_R8: X coordinates
<Y> = VT_R8: Y coordinates
<Z> = VT_R8: Z coordinates

Explanation
Perform triangulation using two or three cameras.
Camera calibration and camera position setup need to be performed before executing this command.
If <Camera3 ID> is 0, then it calculates from two camera data.

Related item CalibrateCamera, SetCamCalDat, GetPosFromCam

TriMatchTemplate

Format *object*.TriMatchTemplate(<Camera1 ID>, <Camera2 ID>, <Camera3 ID>,

<Input ID>, <Method>, <Threshold>, <Start angle>, <End angle>, <Step angle>, <Down sizing>, <Undistorted>, <Tru-Method>)

Parameters

<Camera1 ID> = VT_I4: Camera 1 image number

<Camera2 ID> = VT_I4: Camera 2 image number

<Camera3 ID> = VT_I4: Camera 3 image number(0: Not used)

<Input ID> = VT_I4: Template image number

<Method> = VT_I4: Matching method

(I denotes image, T - template, R - result. The summation is done over template and/or the image patch: x'=0..w-1, y'=0..h-1)		
0	CV_TM_SQDIFF	$R(x,y)=\sum_{x',y'}\left[T(x',y')-I(x+x',y+y')\right]^2$
1	CV_TM_SQDIFF_NORMED	$R(x,y)=\frac{\sum_{x',y'}\left[T(x',y')-I(x+x',y+y')\right]^2}{\sqrt{\sum_{x',y'}T(x',y')^2\cdot\sum_{x',y'}I(x+x',y+y')^2}}$
2	CV_TM_CCORR	$R(x,y)=\sum_{x',y'}\left[T(x',y')\cdot I(x+x',y+y')\right]$
3	CV_TM_CCORR_NORMED	$R(x,y)=\frac{\sum_{x',y'}\left[T(x',y')\cdot I(x+x',y+y')\right]}{\sqrt{\sum_{x',y'}T(x',y')^2\cdot\sum_{x',y'}I(x+x',y+y')^2}}$
4	CV_TM_CCOEFF	$R(x,y)=\sum_{x',y'}\left[T'(x',y')\cdot I'(x+x',y+y')\right]$ where $T'(x',y')=T(x',y')-\frac{\sum_{x'',y''}T(x+x'',y+y'')}{(w\cdot h)}$ $I'(x+x',y+y')=I(x+x',y+y')-\frac{\sum_{x'',y''}I(x+x'',y+y'')}{w\cdot h}$
5	CV_TM_CCOEFF_NORMED	$R(x,y)=\frac{\sum_{x',y'}\left[T'(x',y')\cdot I'(x+x',y+y')\right]}{\sqrt{\sum_{x',y'}T'(x',y')^2\cdot\sum_{x',y'}I'(x+x',y+y')^2}}$

<Threshold> = VT_R8: Threshold

<Start angle> = VT_I4: Search start angle (degree)

<End angle> = VT_I4: Search end angle(degree)

<Step angle> = VT_I4: Step angle degree

<Down sizing> = VT_I4: Down sizing count

<Undistorted> = VT_BOOL: Distortion compensation flag

True	Enable distortion compensation
False	Disable distortion compensation

<Tru-Method> = VT_I4: Triangulation method

0	Liner	Singular value analysis
1	Midpoint	Center point analysis

Return value

<X> = VT_R8: X coordinates

<Y> = VT_R8: Y coordinates

<Z> = VT_R8: Z coordinates

Explanation

Perform template matching for two or three camera images, and use the detected position for triangulation.

Camera calibration and camera position setup need to be performed before executing this command.

If <Camera3 ID> is 0, then it calculates from two camera data.

[Note] From Version 1.3.5, rotation dilection is changed to crockwise.

Related item

CalibrateCamera, SetCamCalDat, GetPosFromCam, MatchTemplate2

Example

[VB6]

```
Set caoCommand = caoController.AddCommand("TriMatchTemplate")
caoCommand.Parameters= Array(1, 2, 0, 11, 3, 0.8, 0, 0, 3, False)
' Detect image in #11 from camera image #1 and #2, and perform triangulation.
' Camera image rotation detect: None(0° ～0° ), Search depth: 3,
' Distortion adjustment: none
caoCommand. Execute 0
vntRet = caoCommand.Result
x = vntRet(0) ' <X>
y = vntRet(1) ' <Y>
angle = vntRet(2) ' <Angle>
```

TriMatchShapes

Format

object.TriMatchShapes(<Camera1 ID>, <Camera2 ID>, <Camera3 ID>, <Input ID>, <Threshold>, <Type>, <Method>, <Min scale>, <Similarity>, <Undistorted>, <Tru-Method>)

Parameters

<Camera1 ID> = Camera 1 image number

<Camera2 ID> = VT_I4: Camera 2 image number

<Camera3 ID> = VT_I4: Camera 3 image number(0: Not used)

<Input ID> = VT_I4: Template image number

<Threshold> = VT_I4: Threshold

<Type> = VT_I4: Threshold type

0	CV_THRESH_BINARY
1	CV_THRESH_BINARY_INV

<Method> = VT_I4: Matching method

A means original image and B means template image in the table below.

0	CV_CONTOUR_MATCH_I1	$I_1(A,B)=\sum_{i=1}^{7}\left\lvert\frac{1}{m_i^A}-\frac{1}{m_i^B}\right\rvert$
1	CV_CONTOUR_MATCH_I2	$I_2(A,B)=\sum_{i=1}^{7}\left\lvert m_i^A-m_i^B\right\rvert$
2	CV_CONTOUR_MATCH_I3	$I_3(A,B)=\sum_{i=1}^{7}\frac{\left\lvert m_i^A-m_i^B\right\rvert}{\left\lvert m_i^A\right\rvert}$

where

$$m_i^A=\sin(h_i^A)\cdot\log(h_i^A)$$
$$m_i^B=\sin(h_i^B)\cdot\log(h_i^B)$$

h_i^A, h_i^B are Hu moments of A and B, respectively.

<Min scale> = VT_R8: Minimum scale

<Similarity> = VT_R8: Contour similarity

<Undistorted> = VT_BOOL: Distortion compensation flag

True	Enable distortion compensation
False	Disable distortion compensation

<Tru-Method> = VT_I4: Triangulation method

0	Liner	Singular value analysis
1	Midpoint	Center point analysis

Return value

<X> = VT_R8: X coordinate

<Y> = VT_R8: Y coordinate

<Z> = VT_R8: Z coordinate

Explanation

Compare object shape using two or three cameras, and perform triangulation using the detected coordinate.
Each camera and its position need to be calibrated before using this function.
Camera image is converted to binary image using Canny filter. Therefore, specify images converted by Canny for <Input ID> image.
If two or more cantors are extracted from <Input ID> image, matching may fail. Therefore, <Input ID> image should be selected so that return value of the FindContours for the image is 1.
If <Camera3 ID> is 0, then it calculates from two camera data.

Related item

CalibrateCamera, SetCamCalDat, GetPosFromCam, MatchShapes2

TriHaarDetect

Format

object.TriHaarDetect(<Camera1 ID>, <Camera2 ID>, <Camera3 ID>, <XML Path>, <Scale>, <Min Neighbors>, <Undistorted>, <Tru-Method>)

Parameters

<Camera1 ID> = VT_I4: Camera 1 image number
<Camera2 ID> = VT_I4: Camera 2 image number
<Camera3 ID> = VT_I4: Camera 3 image number(0: Not used)
<Path> = VT_BSTR: Path to Haar file
<Scale> = VT_R8: Scale
<MinNeighbors> = VT_I4: Minimum neighbor number
<Undistorted> = VT_BOOL: Distortion adjustment flag

True	Enable distortion compensation
False	Disable distortion compensation

<Tru-Method> = VT_I4: Triangulation method

0	Liner	Singular value analysis
1	Midpoint	Center point analysis

Return value

<X> = VT_R8: X coordinates
<Y> = VT_R8: Y coordinates
<Z> = VT_R8: Z coordinates

Explanation

Perform Haar matching for two or three camera image, and use the detected position for triangulation.

Camera calibration and camera position setup need to be performed before executing this command.
If <Camera3 ID> is 0, then it calculates from two camera data.

Related item CalibrateCamera, SetCamCalDat, GetPosFromCam, HaarDetect

5. OcvTester

5.1. Outline

OcvTester is an application using OpenCV provider to perform image-processing process interactively.

With OcvTester, you can perform image processing step by step, and show the processed images on different windows. In addition, OcvTester can record and output the performed image processing procedures in CaoScript scripting language.

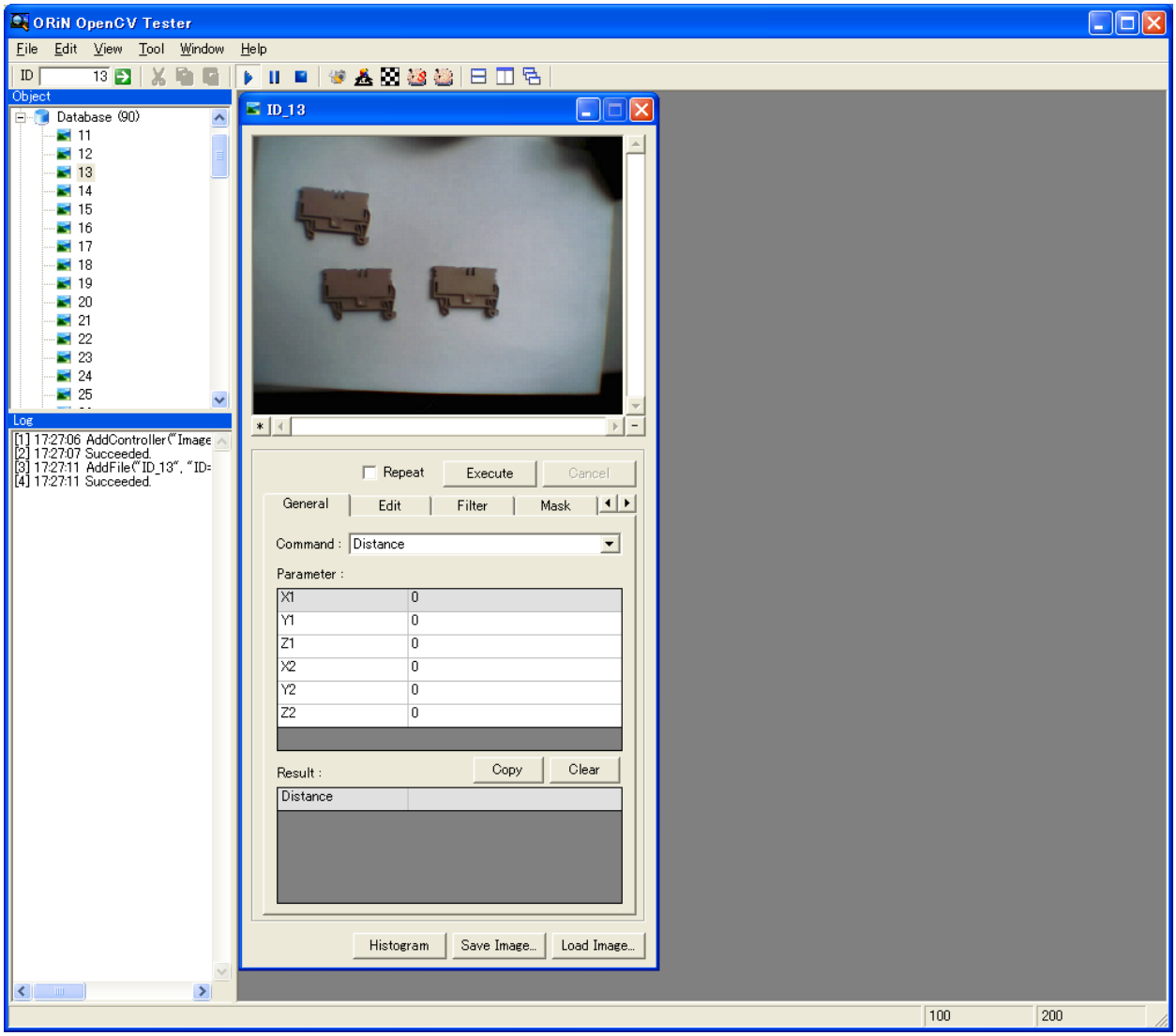


Figure 5-1 OcvTester screen image

Double-clicking the tree view on the left above of the main window displays image window corresponding to the selected node. Image window is used for command execution, and command execution log is displayed in the log window at the left below of the main window.

5.2. Main screen

Main screen is for operations like setup OpenCV provider, manage each windows and file input/output.

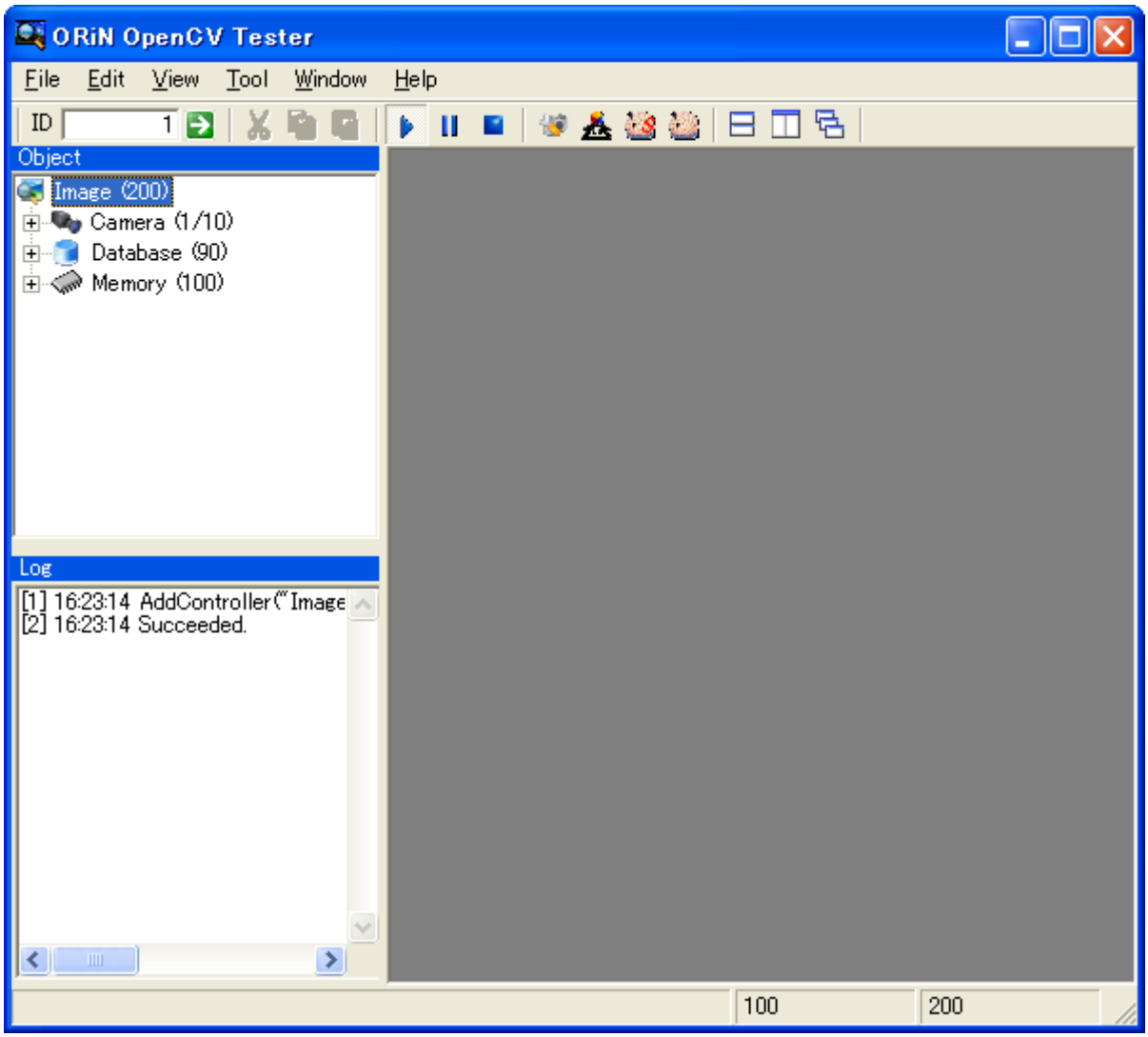


Figure 5-2 OcvTester screen

5.2.1. Object window

Object window is for camera and memory image management.

By double-clicking the object, image window is displayed.

5.2.2. Log window

Command execution log is output on this window.

5.2.3. Menu

5.2.3.1. File menu

This menu is for saving files.

[Export Log]

Output log to a file.

[Export Script]

Output recorded command execution procedure as CaoScript file.

[Connect]

Connect to DENSO robot. When connecting, DENSO robot connection window is displayed. For details, please refer to5.4.

[Disconnect]

Disconnect communication with DENSO robot.

[Exit]

Exit OcvTester.

5.2.3.2. Edit menu

This menu is for editing log output and script record.

[Output Log]

Output command executionlog to log window.

[Clear Log]

Clear log window contents.

[Copy]

Copy text to clipboard.

[Cut]

Cut text and copy to clipboard.

[Paste]

Paste contents of clipboard to text.

5.2.3.3. Display menu

This menu is for screen display setting.

[Object Window]

Display and hide object window.

[Log Window]

Display and hide log window.

[Script Viewer]

Display CAO Script Viewer.

[Main Screen]

Display and hide main screen.

5.2.3.4. Tool Menu

This menu is for tool menu display.

[Camera Setting]

Display camera setting tool. For details, please refer to 5.5

[Triangulation]

Displays triangulation window. For details, please refer to 5.6

[Calibration]

Display calibration wizard. For details, please refer to 5.6.

[Image Samples]

Displays image sampling creation tool. For details, please refer to 5.9

[Haar Training]

Displays Haar training tool. For details, please refer to 5.10

5.2.3.5. Script menu

This menu is for CAO script automatic generation function setting.

[Start Recording]

Start command execution recording.

[Pause Recording]

Pause command execution recording. When the recording is resumed, the command record is added to the paused command record.

[Stop Recording]

Stop command execution recording. When the recording is started next time, previous command record is destructed.

[Copy Script]

Copy currently recorded CAO script to clipboard.

[Clear Script]

Clear currelntly recorded CAO script.

[Script Manager]

Start CAO script manager.

5.2.3.6. Window menu

This menu is for window display setting.

[Horizontal]

Allign child windows horizontally.

[Vertical]

Allign child windows vertically.

[Cascade]

Cascade chile windows.

[Arrange Icon]

Arrange minimized window icons.

[Close All]

Close all child windows.

5.2.3.7. Help Window

This window is to display help information.

[Version]

Display verion information.

5.3. Image window

Image window is to display images and perform image-processing command.

Command execution procedure is as following.

1. Select command type from tab.
2. Select command from Command combo-box.
3. Set executed command parameter.
4. Press Execute button to execute command.
5. Result displays acquired value. (Some commands don't acquire value.) Executed result is shown in the log window at the left bottom part of the main screen.

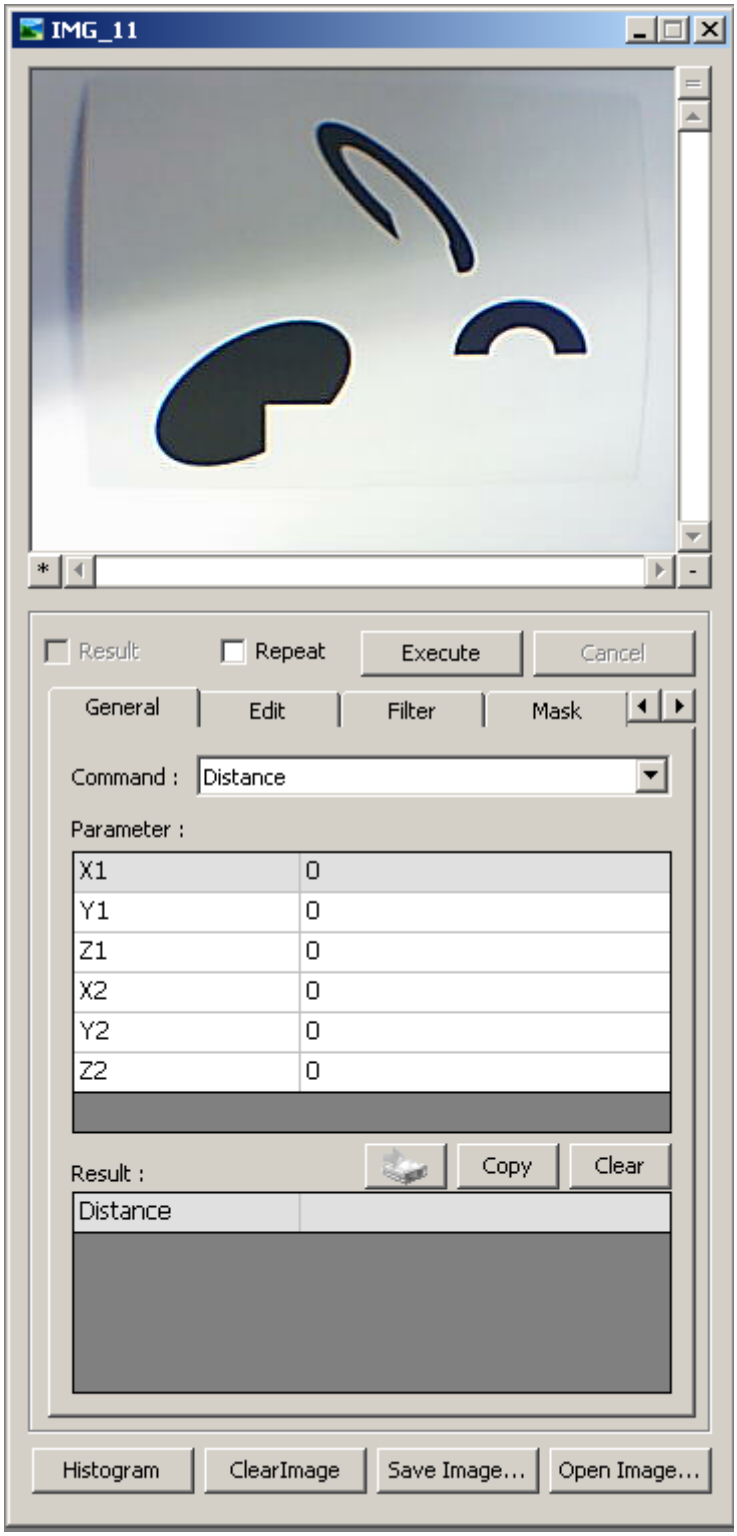


Figure 5-3 Image window

[Image monitor]

Display image to image window.

When left below [*] button is ON, the image is output to main screen.

The capture screen is displayed by [=] button in the upper right corner. This function is valid only for the memory area image.

Right below [+] button and [-] button is to display and hide image monitor.

In some commands, parameter setting by dragging on an image is possible. Following is the list of the command supporting area assignment.

Table 5-1 List of commands supporting area assignment

Shape	Command	Operation	
Rectangle	SetROI Cut Rectangle CamShift	Move	5pixels : [↑] [↓][←][→] 1pixel : [Ctrl] + [↑] [↓][←][→]
		Resize	5pixels : [Shift] + [↑] [↓][←][→] 1pixel : [Ctrl] + [Shift] + [↑] [↓][←][→]
		Automatic fitting	[Shift]+[Enter]
Line	Line	Move	5pixels : [↑] [↓][←][→] 1pixel : [Ctrl] + [↑] [↓][←][→]
		Resize	5pixels : [Shift] + [↑] [↓][←][→] 1pixel : [Ctrl] + [Shift] + [↑] [↓][←][→]
Point	PutColor GetColor SearchPoint Paste Rotate Line2 Circle Ellipse Sector Cross Text ContoursNumber PointPolygonTest GetPosFromCam BoxPoints	Move	5pixels : [↑] [↓][←][→] 1pixel : [Ctrl] + [↑] [↓][←][→]

[Repeat]

Repeat command execution. To stop repeated command execution, uncheck Repeat, or click Cancel button. Repeated execution outputs large amount of logs.

[Execute]

Execute a command. Execute command selected from Command combo. Values set in Parameter property box is used for execution parameter. The execution result is displayed in Result property box. Execution result is output to log window.

When Repeat is checked, the command execution is repeated until Cancel button is clicked.

[Cancel]

Stop repeatedly executing command.

[Command Type]

Select command type.

[Command]

Select execution command.

[Parameter]

Set parameters for command execution.

[Result]

Display acquired data of command execution result.

Execution result is stored to clipboard by clicking Copy button.

Clicking Clear button clears currently displayed execution result.

Clicking the data transfer button sends result to DENSO robot.

[Histogram]

Display image histogram. Histogram is updated when "CalcHistEx" command is executed.

[Save Image]

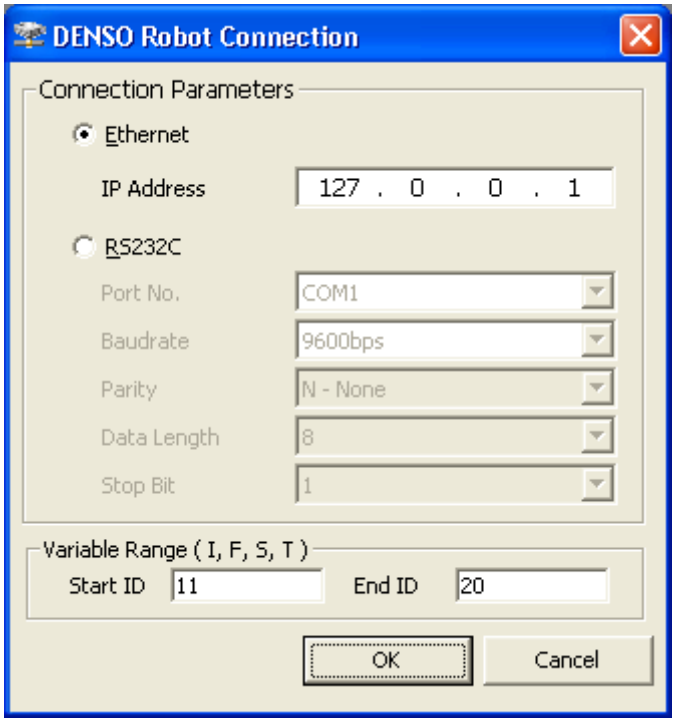
Save image displayed on image monitor as bitmap.

[Load Image]

Load bitmap and display on image monitor. The button cannot be used in image window for camera images.

5.4. DENSO Robot connection window

The window is to setup conditions to connect to DENSO Robot.



[Ethernet]

Use Ethernet to connect to robot controller.

[IP Address]

Specify robot controller IP address.

This parameter is available only when Ethernet connection is selected.

[RS232C]

Use RS232C to connect to robot controller.

[Port No.]

Specify COM port number to communicate to robot controller.

This parameter is available only when RS232C connection is selected.

[Baudrate]

Specify baudrate to communicate to robot controller.

This parameter is available only when RS232C connection is selected.

[Parity]

Specify parity setting to communicate to robot controller.

Only "No parity" is available for this item, and cannot be changed.

[Data Length]

Specify data length to communicate to robot controller.

Only "8bit" is available for this item, and cannot be changed.

[Stop Bit]

Specify stop bit to communicate to robot controller.

Only "1bit" is available for this item, and cannot be changed.

[Variable Range]

Set variable range for DENSO robot result output execution.

5.5. Camera Settings window

Set camera and image memory size.

The setting is effective after restarting OcvTester.

The setting is registered in registry. (refer 2.1)

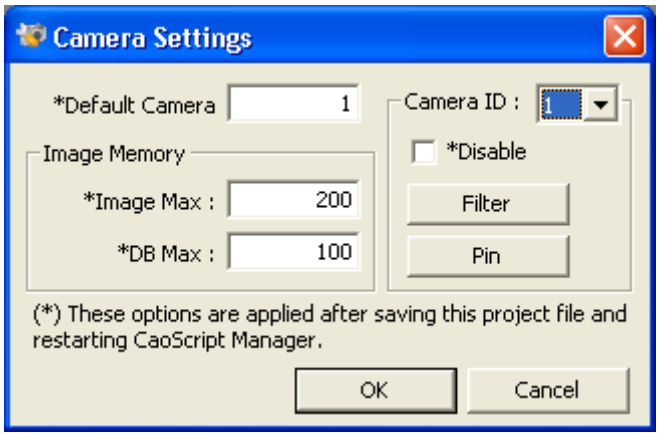


Figure 5-4 Camera Setting window

[Camera ID]

Specify camera ID to setup.

[Disable]

Checking this item disables camera operation.

[Filter]

Open a camera filter property window.

[Pin]

Open a output Pin property window.

[Image Max]

Set image memory max index number.

[DB Max]

Set image database max index number.

5.6. Triangulation window

Calculate coordinate using triangulation.

To use this function, two or three calibrated camera is necessary.

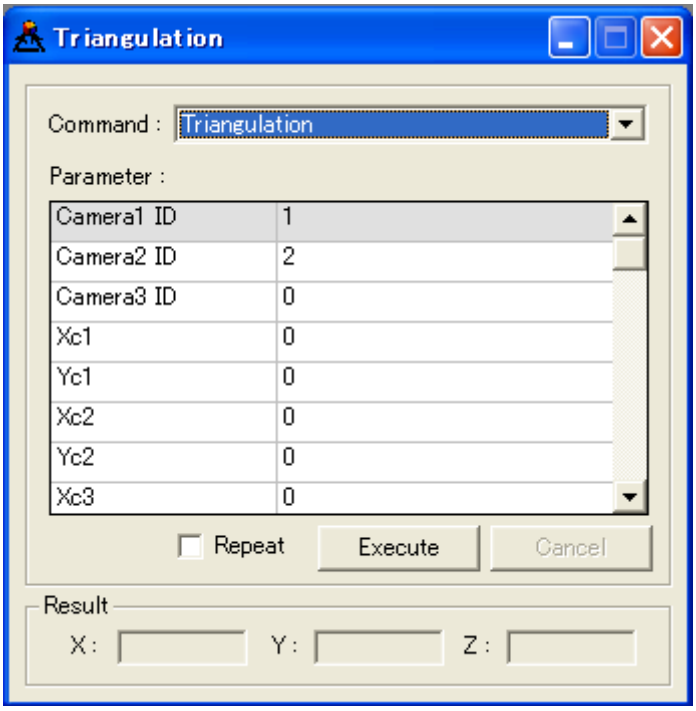


Figure 5-5 Triangulation window

[Command]

Select execution command.

[Parameter]

Set command execution parameters.

[Repeat]

Repeat command execution. To stop repeated command execution, uncheck Repeat, or press Cancel button. Repeated execution outputs large amount of logs.

[Execute]

Execute command. Execute a command selected from Command combo. Values set in Parameter property box is used for execution parameter. The execution result is displayed in Result property box. Execution result is output to log window.

When Repeat is checked, the command execution is repeated until Cancel button is clicked.

[Cancel]

Stop repeatedly executing command.

[Result]

Display acquired data of command execution result.

5.7. Calibration Wizard

5.7.1. Overview

The wizard is for camera calibration and robot calibration.

Calibration wizard supports following four types of calibrations.

[Camera]

Calibrate camera.

CalibrateCamera is called.

[Robot]

Calibrate robot.

CalibrateRobot is called.

[Camera attached on a cell & Robot]

Calibrate attached camera on a cell and robot.

CalibrateCamera and CalibrateRobot is called.

Calibration Wizard performs calibration in the following six steps.

[Step 0] Specify calibration target

[Step 1] Set camera calibration parameter

[Step 2] Acquire chessboard image

[Step 3] Calculate mapping between world coordinate and robot coordinate

[Step 4] Show completion message

Detail of each step is described later in this manual.

Executed step is different depending on the calibration target. Following table shows a list of executed steps for each calibration target.

Table 5-2 Execution steps for each calibration target

Calibration target	Step 0	Step 1	Step 2	Step 3	Step 4
Camera	○	○	○	→	○
Robot	○	→	→	○	○
Camera attached on a cell & Robot	○	○	○	○	○

5.7.2. Step 0: Select calibration target

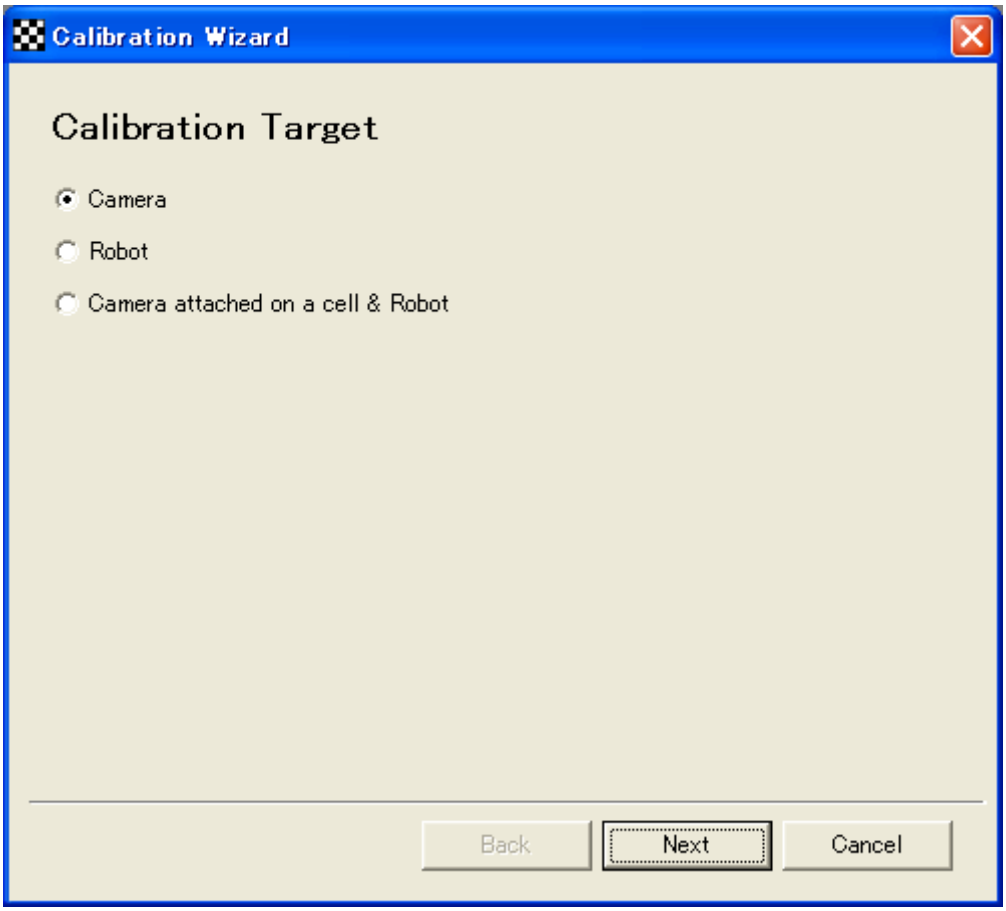


Figure 5-6 Step 0 : Calibration target selection

This screen is to select calibration target. For details of each calibration target, please refer 5.6.1

5.7.3. Step 1 : Set camera calibration parameter

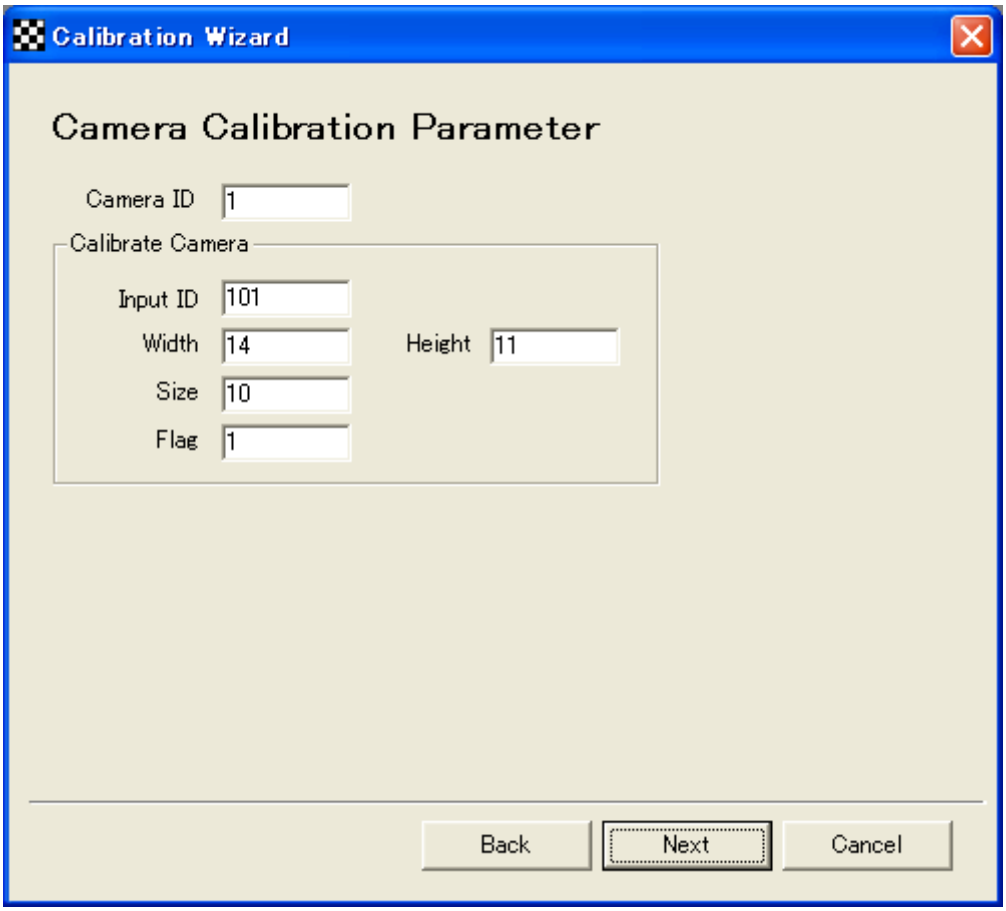


Figure 5-7 Step 1 : Camera calibration parameter setting

[Camera ID]

Specify calibrated camera ID.

[Input ID]

Specify chessboard image storing destination ID for camera calibration. The images are stored sequentially from the specified ID.

[Width]

Specify the width (number of colums) of the calibration chessboard.

[Height]

Specify the height (number of rows) of the calibration chessboard.

[Size]

Specify the square size of the calibration chessboard.

[Flag]

Specify the flag of camera calibration

5.7.4. Step 2 : Acquire chessboard image

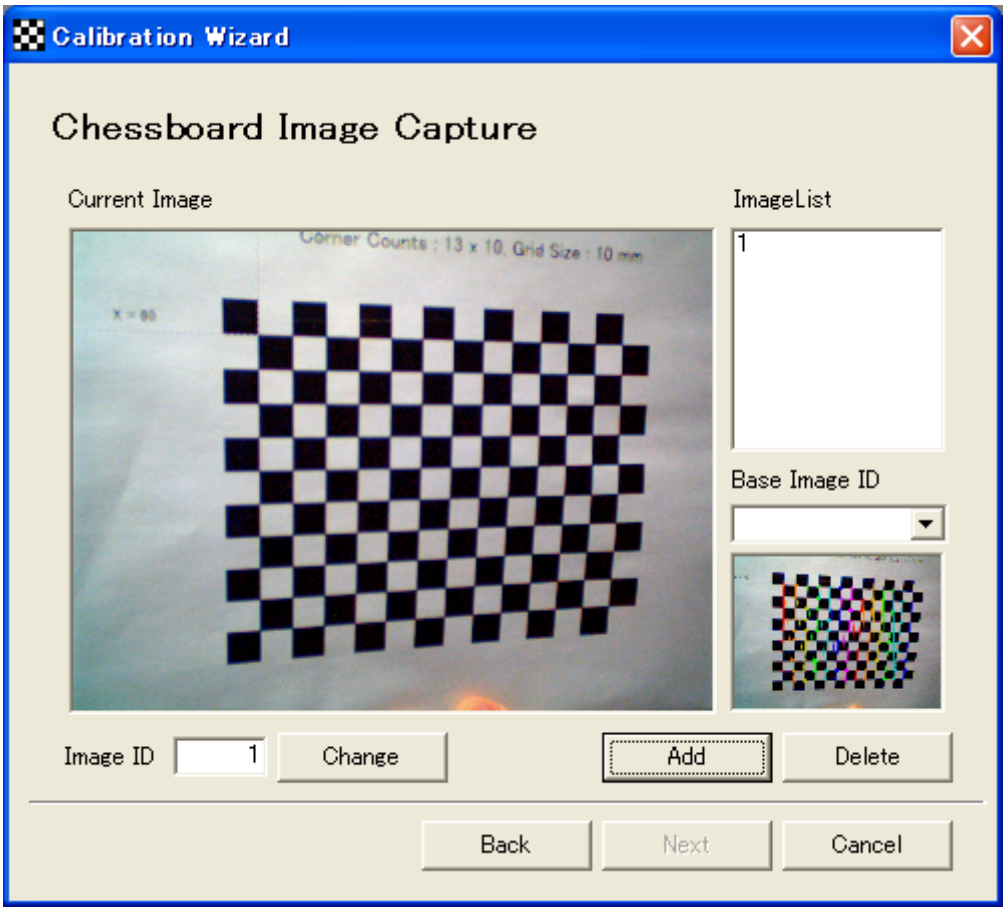


Figure 5-8 Step 3 : Chess board image acquisition

[Current Image]

Display image of the specified ImageID.

[Image ID]

Specify image ID to store acquired image.

[Image List]

Display a list of acquired images. Clicking an item from the list will display a thumbnail image.

[BaseImage]

Specify the image ID that is used as a reference (base) image for camera calibration

[Add]

Add current image to the list. Only images recognized as chessboard image are added to the image list. The chessboard check result is displayed on the thumbnail.

[Delete]

Delete currently selected image from image list.

5.7.5. Step 3 : Map world coordinate and robot coordinate

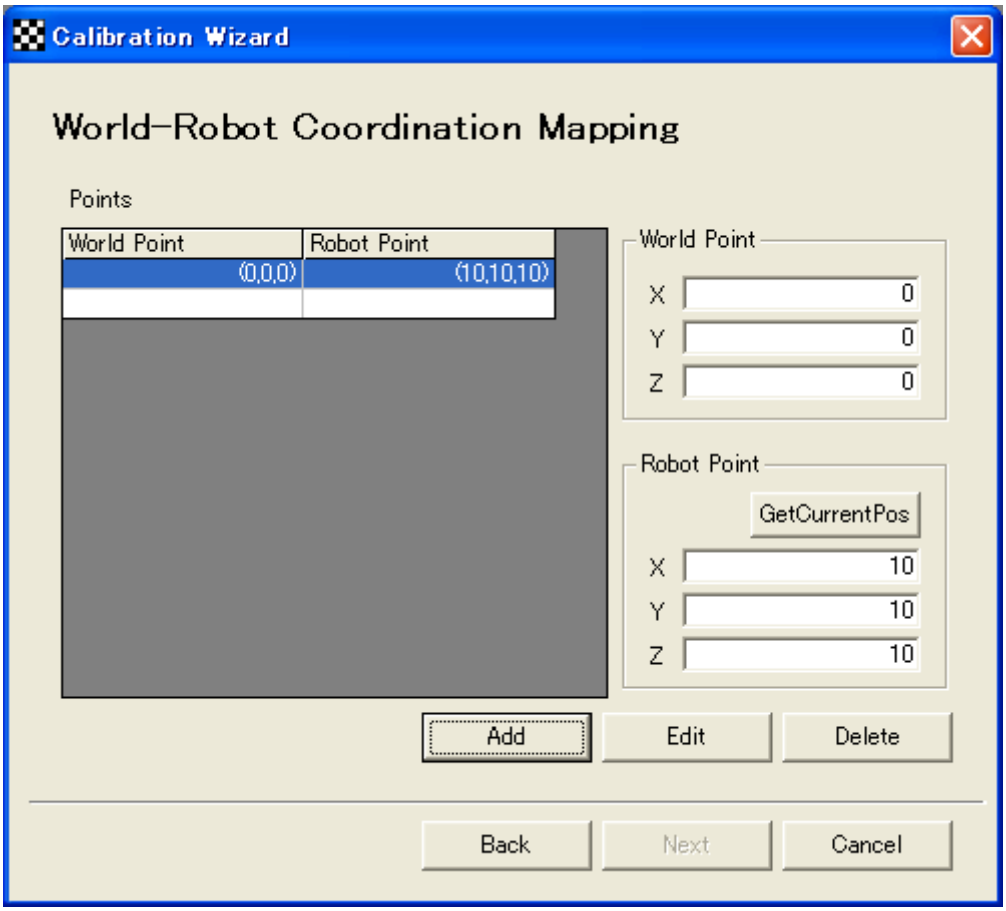


Figure 5-9 Step 4 : World coordinate and robot coordinate mapping

[Points]

Display mapping list of world coordinate and robot coordinate

The selected mapping point list is displayed in input item of world coordinate and robot coordinate.

[World Point]

Specify a point of world coordinate. [NOTE]

[Robot Point]

Specify a point of robot coordinate. [NOTE]

[GetCurrentPos]

Get current position from robot controller, and set to each item of robot coordinate.

[Add]

Add input world coordinate and robot coordinate to list as correspoinding points.

[Edit]

Edit list item of selected world coordinate and corresponding robot coordinate.

[Delete]

Delete selected mapping information form the list.

[NOTE] In case of 'Camera + Robot' Calibration

The left-bottom of the base image (Chessboard) used in the camera calibration is the world origin (0, 0, 0). In case of 'Camera + Robot' calibration, it is easy to use the chessboard for specifying a world point and a robot point. To put it concretely, any points (X, Y, 0) on the chessboard can be specified as a world point. And next, move the robot to the point, and click [GetCurrentPos] to get the current robot point. Repeat those steps more than 3 times. We recommend attaching a teaching pointer like a ball point pen.

5.7.6. Step 4 : Comlete Wizard

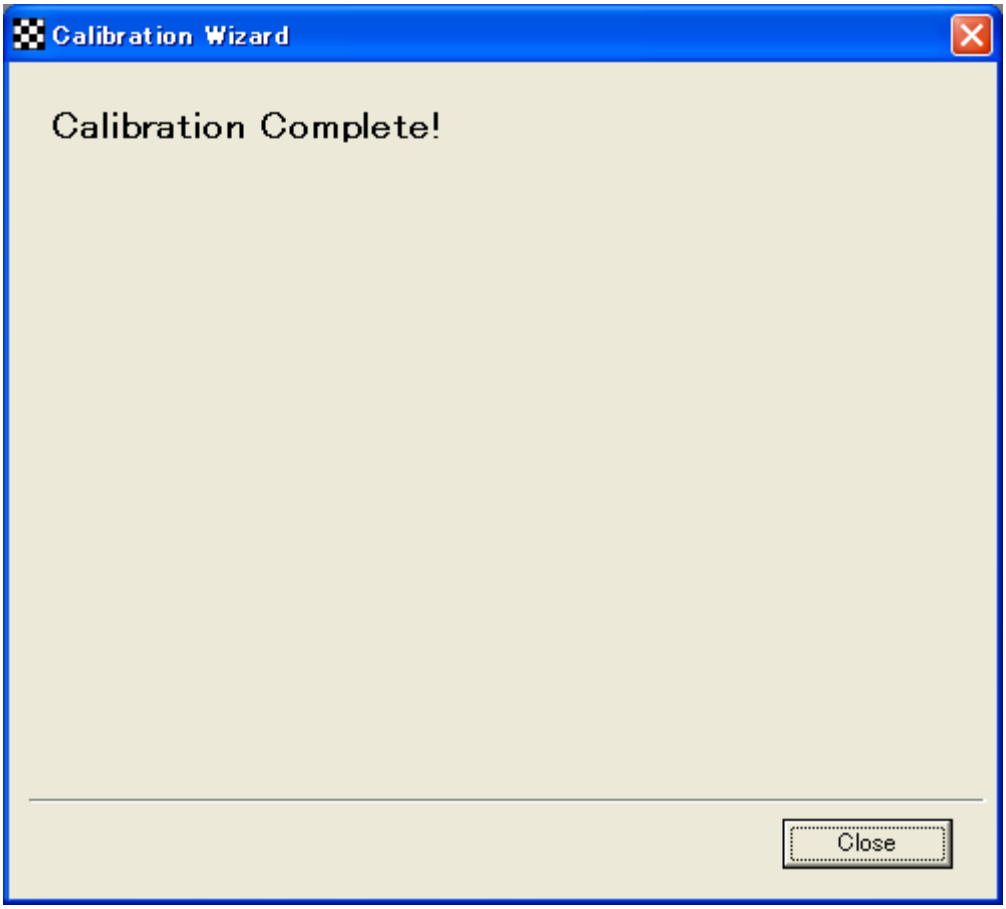


Figure 5-10 Step 5 : Completion screen

This screen is displayed when calibration is finished. Click Close button to exit calibration wizard.

5.8. Lookup table editor

Edit lookup table.

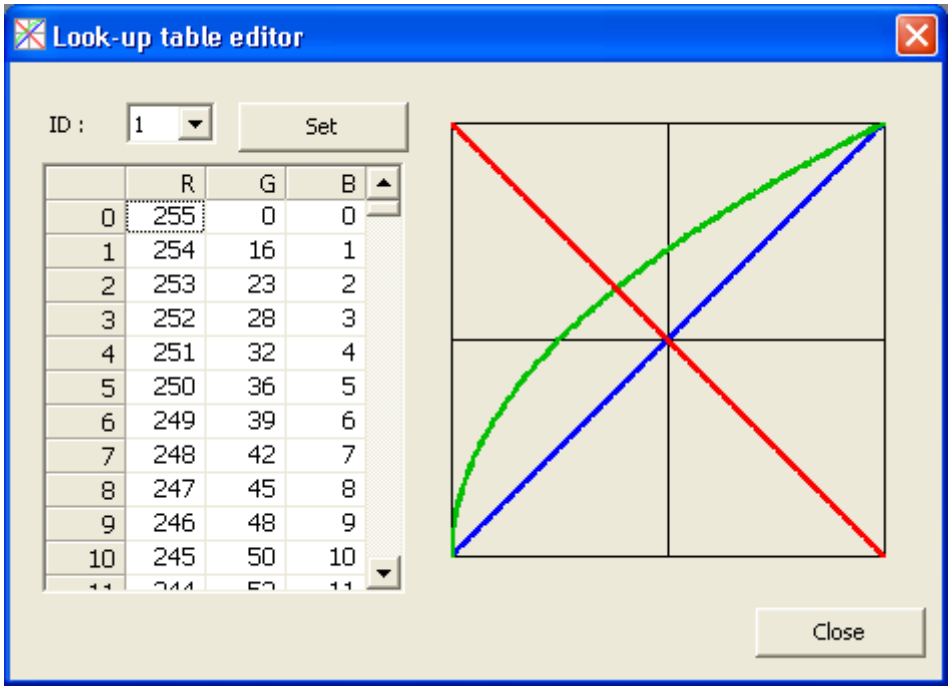


Fig 5-1 Lookup table editor

[ID]

Specify edited lookup table ID.

[Look-up table]

Display and edit current lookup table.

R,G, B shows hue.

[Graph]

Show the graph of each hue of current lookup table.

[Set]

Set edited lookup table.

[Close]

Exit lookup table editor.

5.9. Image sampling window

Create positive image used for Haar training, by using CreateSamples.exe command of OpenCV.

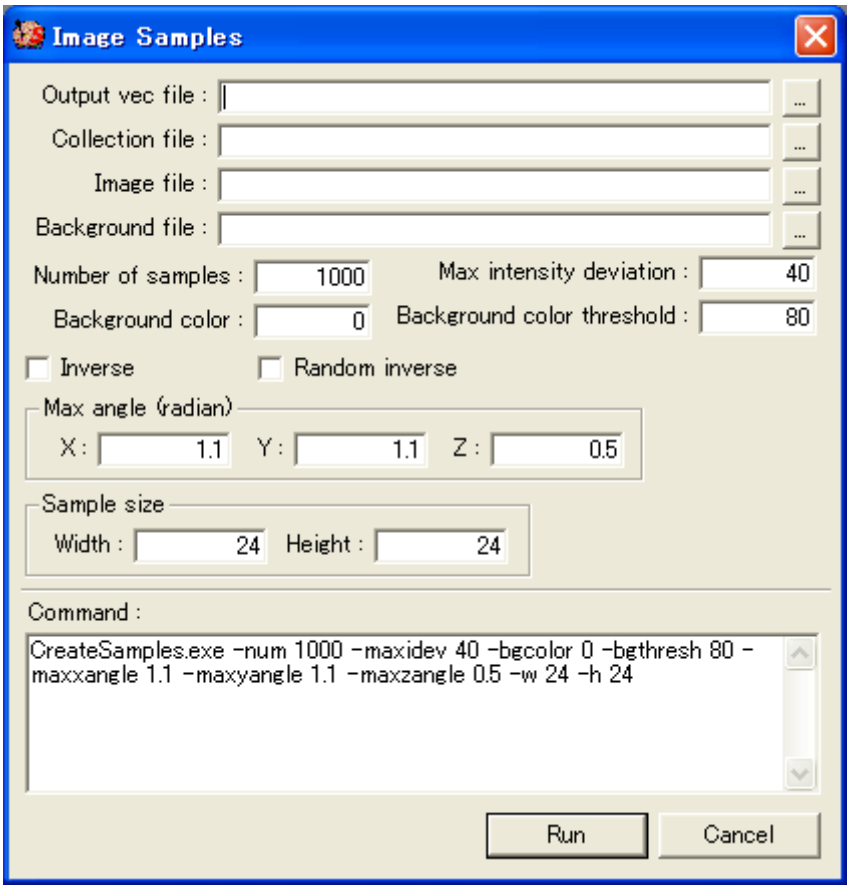


Figure 5-11 Image sampling window

[Output vec file]

Specify created positive file output destination.

[Collection file]

Specify collection file. Collection file describes a list of image files containing detected images. For detailesof the file format, please refer to the document for CreateSamples.exe.

[Image file]

Specify detected image image file.

[Background file]

Specify background image collection file.

[Number of samples]

Specify output positive image sample number.

[Max intensity deviation]

Specify front image maximum intensity deviation.

[Background color]

Change specified background color to transparent.

[Background color threshold]

Change areas of "Background color" plus/minus "background color threshold" to be transparent.

[Inverse]

Inverse color.

[Random imverse]

Randomly inverse color.

[Max angle]

Specify maximum rotation angle of detected image.

[Sample size]

Specify created positive image size.

[Command]

Show executed command in the format of CreateSamples.exe command line.

[Run]

Execute command displayed in Command.

[Cancel]

Cancel command execution and close window.

5.10. Haar training window

Create XML file used in "HaarDetect" command by using HaarTraining.exe command of OpenCV.

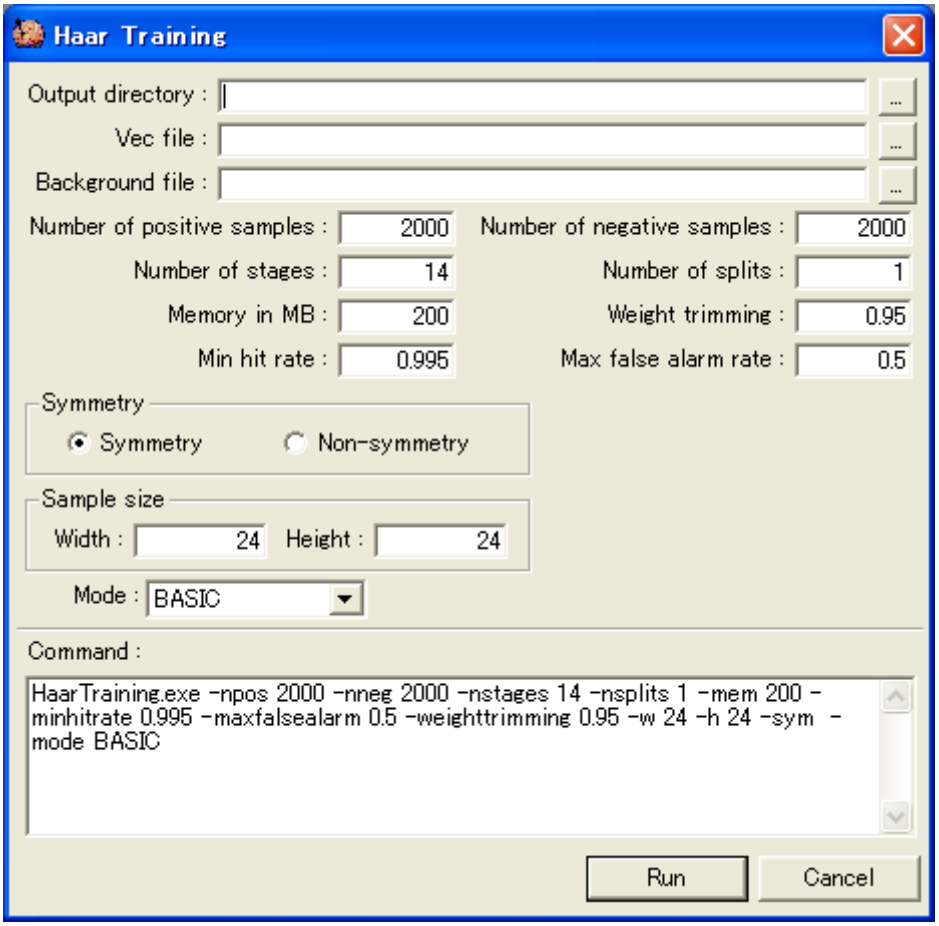

Haar Training
Output directory :
Vec file :
Background file :
Number of positive samples : 2000
Number of negative samples : 2000
Number of stages : 14
Number of splits : 1
Memory in MB : 200
Weight trimming : 0.95
Min hit rate : 0.995
Max false alarm rate : 0.5
Symmetry
Symmetry
Non-symmetry
Sample size
Width : 24
Height : 24
Mode : BASIC
Command :
HaarTraining.exe -npos 2000 -nneg 2000 -nstages 14 -nsplits 1 -mem 200 -minhitrate 0.995 -maxfalsealarm 0.5 -weighttrimming 0.95 -w 24 -h 24 -sym -mode BASIC
Run
Cancel

Figure 5-12 Image sampling window

[Output directory]

Specify Haar training result output directory.

[Vec file]

Specify positive imag4e file.

[Background file]

Specify background file.

[Number of positive samples]

Specify the number of positive samples to be used for stage training of each classifier.

[Number of negative samples]

Specify the number of negative samples to be used for stage training of each classifier.

[Number of stage]

Specify the training stage number.

[Number of split]

Specify number of weak classifiers used in classifier st age. If 1 is specified, simple stump classifier

is used. If 2 or more is specified, CART classifier with "Number of split" internal branch node is used.

[Memory in MB]

Specify the size of memory to be used for calculation.

[Weight trimming]

Specify the degree of using weight trimming.

[Min hit rate]

Specify minimum hit rate necessary for each stage classifier.

[Max flase alarm rate]

Specify maximum false alartm rate reqired for classifiers of each stages.

[Symmetry]

In the training, specify whether the object is symmetry to vertical axis.

[Sample size]

Specify positive image size.

[Mode]

Select Haar characteristics set type used for training.

[Command]

Show executed command in the format of HaarTraining.exe command line.

[Run]

Execute command displayed in Command.

[Cancel]

Cancel command execution and close window.

Appendix A. OpenCV method implementation list

Table A-1 penCV method implementation list

CaoFile::Execute command name	Implemented OpenCV method
SetROI	cvRect cvSetImageROI
GetROI	cvGetImageROI
ResetROI	cvResetROI
PutColor	cvSet2D
GetColor	cvGet2D
ImageSize	-
Trim	cvCreateImage cvGetSize cvCvtColor cvCopy cvReleaseImage cvGet2D
SearchPoint	cvCreateImage cvGetSize cvCvtColor cvCopy cvReleaseImage cvGet2D
Distance	-
InnerProduct	-
OuterProduct	-
Copy	cvCreateImage cvGetSize cvCopy cvReleaseImage
Cut	cvReleaseImage cvRect cvSetImageROI cvCreateImage cvGetSize

	cvCopy
Paste	cvCreateImage cvGetSize cvCvtColor cvRect cvSetImageROI cvCopy cvConvert cvReleaseImage
Rotate	cvCreateImage cvGetSize cvCreateMat cv2DRotationMatrix cvWarpAffine cvReleaseImage cvReleaseMat
Flip	cvCreateImage cvGetSize cvFlip
Resize	cvCreateImage cvSize cvResize
Split	cvCreateImage cvGetSize cvSplit cvReleaseImage
Marge	cvCreateImage cvGetSize cvMerge
ConvertGray	cvCreateImage cvGetSize cvCvtColor cvCopy cvReleaseImage
ThresholdEx	cvCreateImage cvGetSize

	cvCvtColor cvCopy cvThreshold cvReleaseImage
Threshold2	cvCreateImage cvGetSize cvCvtColor cvCopy cvThreshold cvReleaseImage
AdaptiveThresholdEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvAdaptiveThreshold cvReleaseImage
Smooth	cvCreateImage cvGetSize cvSmooth cvReleaseImage
Sobel	cvCreateImage cvGetSize cvCvtColor cvCopy cvSobel cvConvert cvReleaseImage
Laplace	cvCreateImage cvGetSize cvCvtColor cvCopy cvLaplace cvConvert cvReleaseImage
CannyEx	cvCreateImage cvGetSize

	cvCvtColor cvCopy cvCanny cvReleaseImage
WarpAffine	cvCreateImage cvGetSize cvCreateMat cvSetReal2D cvWarpAffine cvReleaseImage cvReleaseMat
WarpPerspective	cvCreateImage cvCreateMat cvSetReal2D cvWarpPerspective cvReleaseMat
PreCornerDetectEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvConvert cvPreCornerDetect cvConvert cvReleaseImage
CornerHarrisEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvConvert cvCornerHarris cvReleaseImage
CalcBackProjectEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvCreateHist

	cvCalcHist cvCalcBackProject
Inpaint	cvCreateImage cvGetSize cvInpaint
Erode	cvCreateStructuringElementEx cvCreateImage cvErode cvReleaseStructuringElement
Dilate	cvCreateStructuringElementEx cvCreateImage cvDilate cvReleaseStructuringElement
PyrDown	cvGetSize cvCreateImage cvPyrDown
PyrUp	cvGetSize cvCreateImage cvPyrUp
NOT	cvCreateImage cvGetSize cvNot
AND	cvCreateImage cvGetSize cvAnd cvReleaseImage
OR	cvCreateImage cvGetSize cvOr cvReleaseImage
XOR	cvCreateImage cvGetSize cvXor cvReleaseImage
ADD	cvCreateImage cvGetSize

	cvAdd cvReleaseImage
SUB	cvCreateImage cvGetSize cvSub cvReleaseImage
MAXEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvMax cvReleaseImage
MINEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvMin cvReleaseImage
ABS	cvCreateImage cvGetSize cvAbsDiff cvReleaseImage
Line	cvCreateImage cvGetSize cvCopy cvLine cvPoint cvReleaseImage
Line2	cvCreateImage cvGetSize cvCopy cvLine cvPoint cvReleaseImage
Rectangle	cvCreateImage cvGetSize

	cvCopy cvRectangle cvPoint cvReleaseImage
Circle	cvCreateImage cvCopy cvCircle cvPoint cvReleaseImage
Ellipse	cvCreateImage cvGetSize cvCopy cvEllipse cvPoint cvSize cvReleaseImage
Sector	cvCreateImage cvGetSize cvCopy cvLine cvEllipse cvPoint cvSize cvReleaseImage
Cross	cvCreateImage cvGetSize cvCopy cvLine cvPoint cvReleaseImage
Text	cvCreateImage cvGetSize cvFlip cvInitFont cvPutText cvPoint

	cvReleaseImage
FindContoursEx	cvCreateImage cvGetSize cvClearMemStorage cvFindContours cvReleaseImage
CopyContours	cvBoundingRect cvReleaseImage cvRect cvSetImageROI cvCreateImage cvGetSize cvCopy
ContoursNumber	cvPointPolygonTest
PointPolygonTest	cvPointPolygonTest
BoundingRect	cvBoundingRect
FitEllipse	cvFitEllipse2
ArcLength	cvArcLenth
CheckContourConvexity	cvCheckContourConvexity
FindBlobs	-
BlobsFilter	-
BlobResult	-
BlobResults	-
BlobEllipse	-
BlobMatchTemplate	cvCloneImage cvCreateImage cvCopy cvGetSize cvResize cvSet cvSetImageROI cvResetImageROI cvCreateMemStorage cvCreateSeq cvPoint2D32f cvSize2D32f

	cvCreateMat cv2DRotationMatrix cvWarpAffine cvBoxPoints cvMatchTemplate cvMinMaxLoc cvSeqPush cvSeqSort cvGetSeqElem cvClearSeq cvReleaseImage cvReleaseMat cvReleaseMemStorage
BlobMatchShapes	cvCloneImage cvCreateMemStorage cvCreateImage cvCvtColor cvCopy cvClone cvFindContours cvBoundingRect cvSetImageROI cvClearMemStorage cvFindContours cvMatchShapes cvFitEllipse2 cvReleaseImage cvReleaseMemStorage
CalcHistEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvCreateHist cvCalcHist cvQueryHistValue_1D cvReleaseHist

	cvReleaseImage
NormalizeHistEx	cvCreateHist cvSetReal1D cvNormalizeHist cvQueryHistValue_1D cvReleaseHist
ThreshHistEx	cvCreateHist cvSetReal1D cvThreshHist cvQueryHistValue_1D cvReleaseHist
EqualizeHistEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvEqualizeHist
GetMinMaxHistValue	cvCreateHist cvSetReal1D cvGetMinMaxHistValue cvReleaseHist
HistAve	-
AutoThreshPTile	-
AutoThreshMode	-
AutoThreshDiscrim	-
MatchTemplate	cvCreateImage cvSize cvMatchTemplate cvMinMaxLoc cvReleaseImage
MatchShapesEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvMatchShapes cvReleaseImage
CamShift	cvRect

	cvTermCriteria cvCamShift
MatchTemplate2	cvCreateImage cvCopy cvGetSize cvResize cvSet cvSetImageROI cvResetImageROI cvCreateMemStorage cvCreateSeq cvPoint2D32f cvSize2D32f cvCreateMat cv2DRotationMatrix cvWarpAffine cvBoxPoints cvMatchTemplate cvMinMaxLoc cvSeqPush cvSeqSort cvGetSeqElem cvClearSeq cvReleaseImage cvReleaseMat cvReleaseMemStorage
MatchShapes2	cvCreateMemStorage cvCreateImage cvCvtColor cvCopy cvClone cvFindContours cvBoundingRect cvSetImageROI cvClearMemStorage cvFindContours

	cvMatchShapes cvFitEllipse2 cvReleaseImage cvReleaseMemStorage
HaarDetect	cvLoad cvCreateMemStorage cvHaarDetectObjects cvGetSeqElem cvReleaseMemStorage
CalibrateCamare	cvCreateMat cvCalibrateCamera2 cvRodrigues2 cvMat cvMatMul cvInvert cvSetReal2D cvGetReal2D cvSet2D cvReleaseMat cvCreateImage cvFindChessboardCorners cvCvtColor cvFindCornerSubPix cvReleaseImage
CalibrateRobot	cvCreateMat cvmSet cvSolve cvReleaseMat
FindChessBoardCorners	cvFindChessboardCorners
DrawChessBoardCorners	cvCreateImage cvCopy cvDrawChessboardCorners
DrawXYAxes	cvCreateImage cvGetSize cvCopy cvLine

	cvPoint cvReleaseImage cvFlip cvInitFont cvPutText
SetCamCalDat	-
GetCamCalDat	-
SetCamCalExtDat	-
GetCamCalExtDat	-
SetRobCalDat	-
GetRobCalDat	-
GetPosFromCam	cvCreateMat cvmSet cvmGet cvMatMul cvReleaseMat
GetCamPos	cvCreateMat cvmSet cvmGet cvMatMul cvReleaseMat
GetPosFromRob	cvInitMatHeader cvCreateMat cvmSet cvmGet cvMatMul cvReleaseMat
GetRobPos	cvInitMatHeader cvCreateMat cvmSet cvMatMul cvmGet cvReleaseMat
Undistort2	cvInitMatHeader cvCreateImage cvUndistort2

GoodFeatureToTrackEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvGoodFeaturesToTrack cvReleaseImage
FindCornerSubPixEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvFindCornerSubPix cvSize cvTermCriteria cvReleaseImage
MomentsEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvMoments cvReleaseImage
MeasureInfo	-
HoughLine	cvCreateMemStorage cvHoughLines2 cvGetSeqElem cvReleaseImage cvReleaseMemStorage
HoughCircles	cvCreateMemStorage cvHoughCircles cvGetSeqElem cvReleaseImage cvReleaseMemStorage
DFTEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvConvart

	cvZero cvMerge cvDFT cvPow cvAdd cvReleaseImage
IDFT	cvCreateImage cvMerge cvDFT cvSplit cvConvert cvReleaseImage
OpticalFlowEx	cvCreateImage cvGetSize cvCvtColor cvCopy cvCalcOpticalFlowLK cvReleaseImage
BoxPoints	cvBoxPoints
FindHomography	cvCreateMat cvmSet cvFindHomography cvmGet cvReleaseMat
QRDecode	-
OCRead	-

Appendix B. uVision21 equivalent OpenCV method

Table B-1 uVision21 function equivalent OpenCV method list

Vision function identifier	Function	OpenCV provider equivalent method
CAMIN	Store image from camera in image memory (processing screen).	File::put_Value = File::get_Value
CAMMODE	Set functions for storing camera image in image memory.	Not implemented (Camera setting should be changed)
CAMLEVEL	Set camera image input level.	Not implemented (Camera setting should be changed)
VISCAMOUT	Display camera image on the monitor.	File::get_Value(ID=0～9)
VISPLNOUT	Display image memory on the monitor.	File::get_Value(ID>10)
VISOVERLAY	Display information in the drawing screen on the monitor.	Not implemented (Image representation method depends on the client program.)
VISDEFTABLE	Set camera image lookup table data for camera image input and output.	Not implemented (Use commands of File::Execute for image processing.)
VISREFTABLE	Refer the lookup table data.	Not implemented
WINDMAKE	Specify the image processing range.	Partially implemented (Similar process can be achieved by cutting out the image with Cut command of File::Execute. However, cutting methods except rectangle is not implemented.)
WINDCLR	Delete window information.	Not implemented
WINDCOPY	Copy window information.	Not implemented
WINDREF	Get window information.	Not implemented
WINDDISP	Display specified window.	Not implemented
WINDMAKE	Specify image processing area	Implemented partially, only rectangle. File::Execite SetROI command
WINDCLR	Clear window setup information.	File::Execite ResetROI command
WINDCOPY	Copy window information.	Get the data by File::Execute GetROI command, and set the data by SetROI

		command.
WINDREF	Get window information	File::Execute GetROI command
WINDDISP	Draw the setup window	Execute SetROI then execute Copy command.
VISSCREEN	Specify drawing screen.	Because two or more of File object can be generated, the output image can be arbitrarily set with the client.
VISBRIGHT	Specify the luminance for drawing.	Not implemented (Brightness can be set on camera side.)
VISCLS	Clear the specified screen by painting out the screen specified with the specified luminance.	The image is cleared by setting EMPTY to File::put_Value. The screen is painted out by specifying the entire screen in Rectangle command of File::Execute, and set the thickness of the line as -1.
VISPUTP	Draw a point on the screen.	PutPoint command of File::Execute
VISLINE	Draw a straight line on the screen.	Line2 command of File::Execite
VISPTP	Draw a straight line connecting two points on the screen.	Line command of File::Execite
VISRECT	Draw a rectangle on the screen.	Rectangle command of File::Execite
VISCIRCLE	Draw a circle on the screen.	Circle command of File::Execite
VISELLIPSE	Draw an ellipse on the screen.	Ellipse command of File::Execite
VISSECT	Draw a sector on the screen.	Sector command of File::Execite
VISCROSS	Draw a cross mark on the screen.	Cross command of File::Execite
VISLOC	Specify the position to draw character.	Text command of File::Execite
VISDEFCHAR	Specify the size and the display method of the character.	Text command of File::Execite
VISPRINT	Display characters and numbers on the screen.	Text command of File::Execite
VISWORKPLN	Specify the processing image memory.	File::ID
VISGETP	Get the luminance of specified coordinates from the image memory (processing screen).	GetP command of File::Execite
VISHIST	Get histogram of the screen (intensity distribution).	CalcHistEx command of File::Execite
VISREFHIST	Read histogram result.	CalcHistEx command of File::Execite
VISLEVEL	Select binary level from the histogram result.	Following command in File: Execute

		AutoThreshPTile AutoThreshMode AutoThreshDiscrim
VISBINA	Binalize the screen.	Following command in File: Execute ThresholdEx Threshold2
VISBINAR	Display the binarized screen image.	Following command in File: Execute ThresholdEx Threshold2
VISFILTER	Apply filter on the image.	Smooth command of File::Execite
VISMASK	Mask operations	Mask system command of File::Execite (AND and OR, etc.)
VISCOPY	Copy screen.	File::put_Value = File::get_Value
VISMEASURE	The feature (area, center of gravity, and principal axis angle) in the window is measured.	Combination of the commands of File::Execite Moments,MesureInfo,ImageSize
VISPROJ	Measure the projection data in the window.	Not implemented
VISEDGE	Measure the edge in the window.	Filter system command of File::Execite (Canny and Laplace, etc.)
VISREADQR	Read QR code	File::Execite QRDecode command
BLOB	Labeling	FindContoursEx command of File::Execite
BLOBMEASURE	Measure the feature of the object specified by label number.	Combination of the following commands of File::Execite FindContoursEx, CopyContours, Moments, MeasureInfo, ImageSize
BLOBLABEL	Get the label number of specified coordinate.	Following command in File: Execute ContoursNumber PointPolygonTest
BLOBCOPY	Copy object label number.	CopyContours command of File::Execite
SHDEFMODEL	Register search model	Put_Value
SHREFMODEL	Refer the registered model data.	Combination of the following commands of File::Execite MomentsEx, MeasureInfo, ImageSize
SHCOPYMODEL	Copy registered model data.	File::put_Value = File::get_Value

SHCLRMODEL	Clear registered model data.	The image is cleared by setting EMPTY to File::put_Value. The screen is painted out by specifying the entire screen in Rectangle command of File::Execute, and set the thickness of the line as -1.
SHDISPMODEL	Display registered model on the screen.	Get_Value
SHMODEL	Search model	Following command in File: Execute TemplateMatch HaarDetect MatchEx
SHDEFCORNER	Set condition for corner search.	HoughLine command of File: Execute
SHCORNER	Search corners.	HoughLine command of File: Execute
SHDEFCIRCLE	Set condition for circle search.	HoughCircles command of File: Execute
SHCIRCLE	Search circle.	HoughCircles command of File: Execute
VISGETNUM	Get image processing result from image memory.	Return value of Execute Get_Value(For the image.)
VISGETSTR	Get code recognition result.	Return value of File::Execute QRDecode command
VISPOSX	Get image processing result (X coordinates) from the storage memory.	Return value of File::Execute
VISPOSY	Get image processing result (Y coordinates) from the storage memory.	Return value of File::Execute
VISSTATUS	Refer the processing result of each instruction.	Return value of File::Execute
VISREFCAL	Get CAL (vision - robot coordinate transformation) data.	CAL relation

Appendix C. Intel License Agreement For Open Source Computer Vision Library

Copyright © 2000, Intel Corporation, all rights reserved. Third party copyrights are property of their respective owners.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistribution's of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
- Redistribution's in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- The name of Intel Corporation may not be used to endorse or promote products derived from this software without specific prior written permission.

This software is provided by the copyright holders and contributors "as is" and any express or implied warranties, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose are disclaimed. In no event shall Intel or contributors be liable for any direct, indirect, incidental, special, exemplary, or consequential damages (including, but not limited to, procurement of substitute goods or services; loss of use, data, or profits; or business interruption) however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of this software, even if advised of the possibility of such damage.

All information provided related to future Intel products and plans is preliminary and subject to change at any time, without notice.